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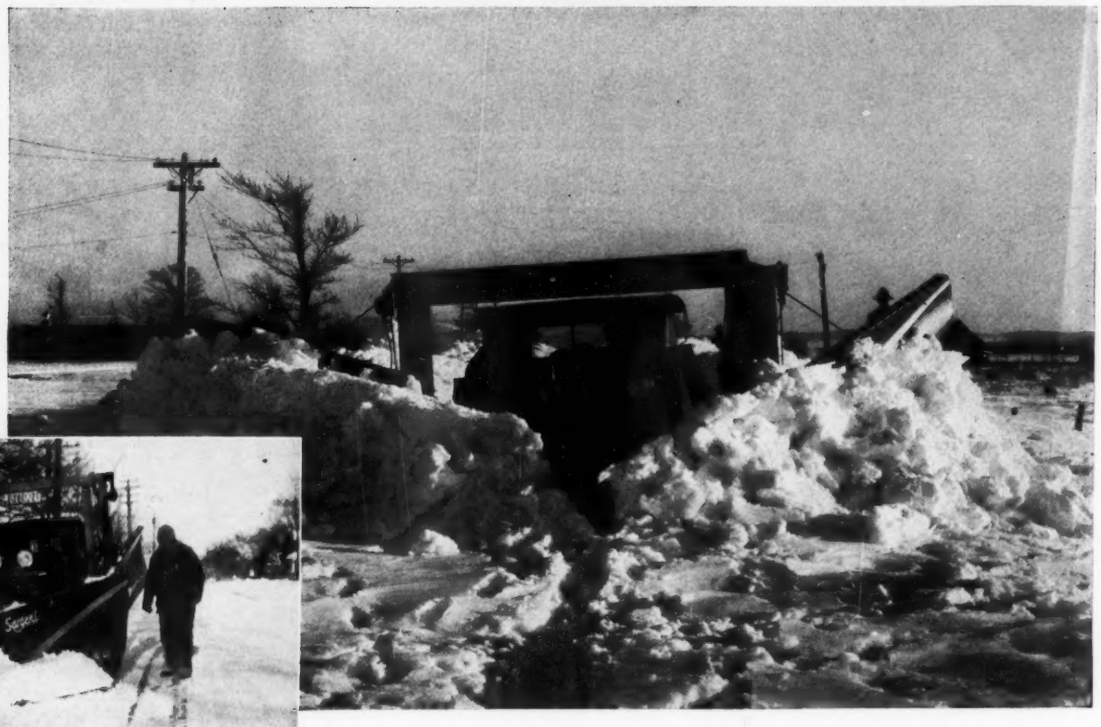
January 20, 21, 22, 23 and 24

DECEMBER, 1935

'WAY DOWN EAST ...they know CLETRAC



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DECEMBER, 1935

December 1935

PUBLIC WORKS

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●The Annual Index, covering the issues of January-December, inclusive, 1935, has been prepared and will be mailed to any subscriber on request to the Editor.

TIMEWASTERS

Look Out for This One:

If butter is a cent and a quarter a pound, how much butter can you buy for 26 cents? *Miss Barbara Dwyer,* City Engineer's Office, Port Jervis, N. Y.

And for This One, Too:

P. L. Brockway, city engineer of Wichita, Kans., along with a lot of others, wrote about the "Squawkie" problem, which is explained below. Mr. Brockway submitted a problem of his own, too: "How many cubic feet of earth in a hole 3′ 4″ wide, 12′ 7½″ deep and 18′ 2″ long?" Go to it, boys, but look out for the trees; you're in the forest now.

The Bewildered Engineer:

A locomotive engineer spots two cars on the horns of a "Y" but gets the car intended for Factory A, which is located on one horn of the Y, in front of Factory B, which is on the other horn, and vice versa. The stem of the Y, or the stub, will accommodate either one car or the locomotive, but no more. The problem is to get the cars into proper position. The engineer scratched his head and did some figuring. He solved the problem finally. Can you? Try it with buttons or coins (if you have any). Contributed by *Stanley Strine, Marion, O., via Bob Clark.*

Thanks to the Brothers:

A whole regiment of gentlemen rushed to our assistance when they read our call of distress (we didn't really mean it to be that) in November *Timewasters,* and now we have at hand a considerable variety of solutions and methods of solutions for the Tin Box problem. Thanks, all of you, the correct solution is 1.666666666667, etc.

The phonograph problem was a catchy one, of course. The needle remains more or less still while the record revolves, with the consequence that it moves, in this problem, a distance of 5 inches horizontally. QED.

The Grecian farmer boys, as very many of our readers have pointed out to us, simply traded horses for the race. It was then to the interest of the rider to get there first. Takes a little thought, though, which is not so abundant as to require plowing under by the AAA or any other organization.

Russell Chatfield gobbles up Mr. Bevan's problem of finding the value of a unit angle so that 5 angles are numerically their own sines, and chips in with even a harder one. Coming soon!

A Merry Christmas and a Happy New Year.

W. A. H.

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A. PRESCOTT FOLWELL, *Editor* **W. A. HARDENBERGH,** *Asso. Editor*

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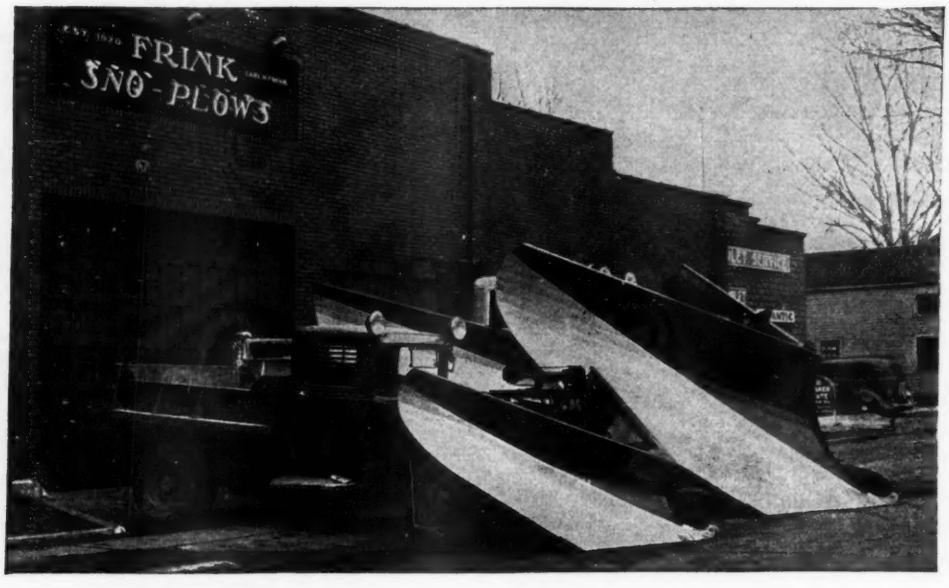

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PUBLIC WORKS

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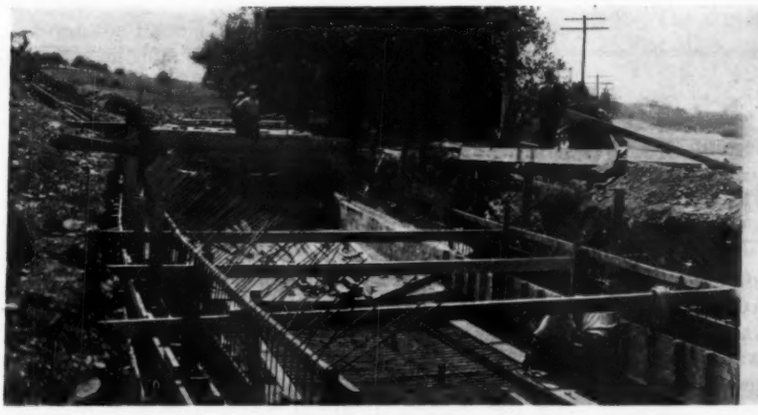
Vol. 66 *December, 1935* No. 12



15 x 5.5-foot concrete box section sewer on Dixon Street ready for pouring.

48-inch reinforced concrete pipe on South Fourth Street.

Designing and Construction Costs of Storm Sewer in Allentown, Pa.

By Earle W. Meckley

City Engineer

THE city of Allentown, Pa., built in 1934 storm water sewers which form a part of a system designed for the 19th Ward, a new addition to the city. These were selected for immediate construction so as to obtain the relocation and reconstruction of State Highway No. 153 by the State, and also eliminate the flooding of certain streets and residential properties in the ward.

Trout creek flows from east to west across this part of the city, with a steep hillside 500 to 600 feet high on its south bank. The channel is quite steep for two miles or more, then rapidly flattens out; at which point it crosses Chapel Road, runs parallel and close to Trout St. for about 1,200 ft., then crosses South 4th St. (formerly called Philadelphia Pike), then swings south across Dixon St. and again west. As a part of the work herein described, the section paralleling Trout St. was relocated in that street and enclosed in a box sewer, which makes a flatter bend than did the creek, crosses South 4th St. and Dixon St., and discharges into the old channel.

Trout creek is normally a quiet, shallow stream, but after a heavy storm rises quickly and flows rapidly down to the flat land referred to, where the streets had been subject to washouts with every heavy rain and the properties flooded at frequent intervals. The resulting traffic tie-ups and property damage were increased by the discharge from a small tributary from the south which paralleled the Philadelphia Pike. The new construction takes care of this by carrying the flow in a reinforced concrete pipe sewer.

In addition to constructing these sewers, the channel of Trout creek has been lowered and widened for 1,500 ft. east of the trunk sewer as an SERB project.

Designing the Sewers

In studying the problems of the sewer capacity needed, existing bridges and culverts through which the streams passed were measured for their waterway areas and their maximum discharges computed. Beginning with one on Albert St., where the east end of the box sewer was to be located, and progressing down stream, the calculated discharges were: 292 cfs, 411 cfs, 591 cfs, 680 cfs, 516 cfs, and finally a railroad culvert of three concrete arches with a combined capacity of 2131 cfs. All except the last had insufficient waterways in time of floods and had been chiefly responsible for the flooding.

To eliminate these flood conditions, and also the construction of an indefinite number of small bridges or culverts of adequate waterway area at every street crossing of Trout Creek, it was decided to build a trunk sewer having its flow line about 2.5 ft. lower than the existing creek bed. Another factor that made the trunk sewer necessary was the location of the creek in Trout St. east of So. 4th St.; for the development of the street would eventually mean the encasement of the stream in a sewer. The box-section type was selected because of limited head room between the finished street grades and the sewer flow lines.

Because of the cost involved, only 825 ft. of box sewer was built; but this eliminated three of the small

STORM SEWER DESIGN—19TH WARD

TROUT CREEK STUDY n = 0.035—Open Channel		Distance Between Stations	Difference in Elevation	Grade %	STREAM STUDY: Velocity	Time in Minutes	Total Time	Intensity I	Area Increment	Total Area Acres	Run-off Coeff.	Run-off C.F./Sec. Q = AIC	Area Sq. Mi.
From Source	To												
A	B	6250	170	2.70	3.5	30	30	1.38		672	0.5	464	1.05
B	C (S. Albert)	3700	60	1.62	3.0	21	51	.90	569	1241	0.5	559	1.93
C	D (S. 5th St.)	4100	60	1.46	4.0	17	68	.71	650	1891	0.5	671	2.95
D	E	2240	26.7	1.19	4.0	9	77	.63	509	2400	0.5	756	3.75
E	F	2370	22.5	0.95	3.8	10	87	.57	249	2649	0.5	755	4.14
		1270	9.9	0.70	3.0	7	94	.53	10	2659	0.5	705	4.15
SO. 4TH ST. SEWER (Conc. Pipe) n = 0.013													
Summit to Normandy Av.							15	2.20	120	120	0.5		
Normandy Ave. to Pt. 550 ft. North		550		7.5	22	0.4	15.4	2.17		120	0.5	132	30"
550 ft. North to Mountain Road		600		6.25	22	0.5	15.9	2.12		120	0.5	129	33"
Mountain Rd. to Ester St.		450		6.25	22	0.3	16.2	2.10	25	145	0.5	154	36"
Ester St. to Turbot St.		300		5.0	21	0.2	16.4	2.08	8	153	0.5	161	36"
Turbot St. to Troy St.		420		5.5	22	0.3	16.7	2.06	5	158	0.5	164	36"
Troy St. to Emaus Ave.		450		5.5	22	0.3	17.0	2.04	8	166	0.5	171	36"
Emaus Ave. to Cooper St.		500		3.25	19	0.4	17.4	2.01	9	175	0.5	179	42"
Cooper St. to Mason St.		350		3.0	19	0.3	17.7	1.99	5	180	0.5	181	42"
Mason St. to Bristol St.		600		0.5	10	1.0	18.7	1.92	7	187	0.5	187	48"
Bristol St. to Trunk Sewer		140		0.5					1	188		188	48"

existant bridges, simplified the spanning of the creek by the new highway, and, in providing considerable change of alignment, enabled the removal of some sharp bends and turns, and provided a water course with long tangents and connecting curves of large radii.

A stream study sheet was then made up, to calculate the discharge of Trout Creek at various points and the proper size of box-section sewer to be used at each of them. The computations for this work were based on a 1-year frequency curve, based on the equation $I = \frac{55}{T+10}$, in which, I=Intensity of rainfall, and T=Time of concentration, in minutes. This curve has been in use here for a number of years for sewer design and has proved satisfactory, in that, during two floods which have occurred in recent years (Aug., 1933 and July, 1935) which were as severe as any since the flood of 1902 (the worst in Allentown's history of 50 years or more) and not far from the 1902 record, every sewer in the city functioned properly; only one flooded condition was attributable to sewer trouble, and this was because of a blocked inlet grate on a flat grade.

The rainfall prior to the 1935 flood is shown on the graph in figure 4. However, the ground was thoroughly saturated from heavy rainfalls in the preceding week, and consequently the run-off was greater than normal. The gauge from which this graph was plotted was not in the Trout Creek area, but at a point about five miles north, so there is a possibility that the rainfall in the sewerage area might have been greater than shown; the manner in which some other streams

COST OF CONSTRUCTION

The itemized costs of the completed project areas follow:

Description	Unit & Cost	Total Cost
15′ x 5.5′ reinf. conc. box section	825.00 lin. ft. @ $33.68	$27,786.00
48″ reinf. conc. pipe sewer	701.90 lin. ft. @ 8.93	6,267.97
42″ reinf. conc. pipe sewer	874.60 lin. ft. @ 6.52	5,702.39
36″ reinf. conc. pipe sewer	1,634.30 lin. ft. @ 5.21	8,514.70
36″ std. reinf. conc. culv. pipe sewer	257.80 lin. ft. @ 5.53	1,425.63
33″ reinf. conc. pipe sewer	792.40 lin. ft. @ 4.54	3,597.50
30″ reinf. conc. pipe sewer	369.60 lin. ft. @ 3.62	1,337.95
24″ reinf. conc. pipe sewer	24.00 lin. ft. @ 2.56	61.44
20″ concrete pipe sewer	42.00 lin. ft. @ 2.15	90.30
15″ concrete pipe sewer	444.00 lin. ft. @ 1.31	581.64
Std. brick M. H. on pipe sewer	18 @ 65.00	1,170.00
Std. brick M. H. on box section	3 @ 50.00	150.00
Special type conc. & brick M. H.	1 @ 425.00	425.00
Std. type "A" 30″ inlet	1 @ 55.00	55.00
Std. type "E" 30″ inlet	31 @ 55.00	1,705.00
Std. type "G" inlet	6 @ 55.00	330.00
12″ conc. pipe stub end	4 @ 2.00	8.00
15″ conc. pipe stub end	2 @ 3.00	6.00
36″ std. R. C. culv. pipe stub end	1 @ 16.00	16.00
12″ conc. pipe inlet connection	949.00 lin. ft. @ .97	920.53
15″ conc. pipe inlet connection	89.00 lin. ft. @ 1.21	107.69
18″ conc. pipe inlet connection	15.00 lin. ft. @ 1.54	23.10
24″ R. C. pipe inlet connection	116.00 lin. ft. @ 2.42	280.72
30″ R. C. pipe inlet connection	28.00 lin. ft. @ 3.46	96.88
Channel excavation	567.00 cu. yd. @ .75	425.25
Extra earth excavation	30.46 cu. yd. @ 2.00	60.92
Rock excavation	379.30 cu. yd. @ 5.00	1,896.50
Extra concrete Class 1, 1:2:4	49.35 cu. yd. @ 15.00	740.25
Extra concrete Class 3, 1:3:6	20.10 cu. yd. @ 9.00	180.90
Sheeting left in place	2.23M.ftBM@ 35.00	78.05
6″ tile underdrain	950.00 lin. ft. @ .40	383.60
Std. concrete curb	9,921.10 lin. ft. @ .55	5,456.61
Std. concrete sidewalk	6,961.00 sq. ft. @ .18	1,252.98
TOTAL COST OF PROJECT COMPLETE		$71,134.50

in the area rose to flood heights so rapidly would tend to bear out this conclusion.

As will be seen from the study sheet, a run-off of 756 cfs is obtained for the design of the box-section, using the 1-year curve and a 0.50 run-off coefficient. For a 100% run-off, using the rational method and the 1-year curve as in the stream study, Q = AIC = 2400 x .63 x 1.0 = 1,512 cfs.

Using McMath's formula, $Q = cr\ (s)^{0.2}\ (A)^{0.8}$; in which cr = 3.39 (suburban), a discharge of 1,715 cfs is obtained. In this formula, s = slope; A = area in acres.

From the Penn'a. Dept. of Waterways run-off sheets, based upon maximum flood discharges in the State, a discharge of 1725 cfs is given as the maximum expected run-off.

Because of the fact that the 19th Ward is now only partially developed and the remaining terrain in Salisbury Twsp. but sparsely settled, and the possibility that both of these areas in the near future might become built up, it was thought wise to design the sewer for the 100% run-off figure of the rational method. Another reason for so doing was the fact that the drainage area run-off could not be computed as accurately as when divided into city blocks, and the grades established. Inasmuch as the 100% run-off discharge compares favorably with the maximum expected run-off, it was used for the design.

The final design data and hydraulic elements for the box section sewer are as follows:

Size, 15'-0" x 5'-6"

Slope—.0085

Coeff. of roughness, "n"=.013

Area, total—79.19 sq. ft.

Area, 6" from top—72.44 sq. ft.

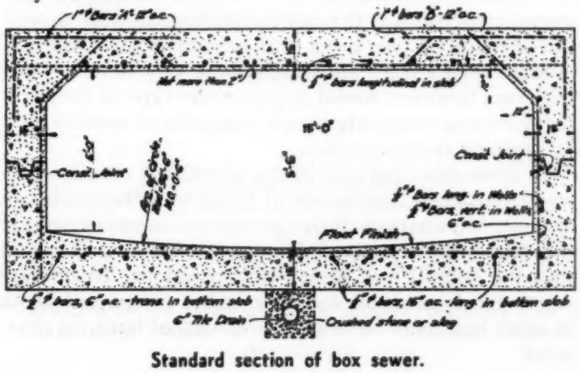
Hydr. Rad. 6" from top, $\frac{A}{P} = \frac{72.44}{24.46} = 2.96$

Velocity filled to 6" from top (Kutter) = 21.80 ft. per sec.

Discharge Q = AV = 72.44 x 21.80 = 1,579.19 cfs.

During the flood of July 9, 1935, the sewer was filled to a depth of 3 ft. and carried away all of the water without any difficulty; here again it might be emphasized that this was the worst flood for 33 years. The velocity of the flow at the intake end of the sewer for this flood was 17.6 ft. per sec., the filled area 42.72 sq. ft. and the discharge 752 cfs. Fortunately the widening and deepening of the channel was so far advanced when this flood came that no land along this channel was inundated, as had formerly occurred.

The box-section was designed to carry the live load stresses developed by 20-ton trucks, including impact where there was but slight earth fill on the sewer, and the earth fill but no impact where the fill occurred to any extent.

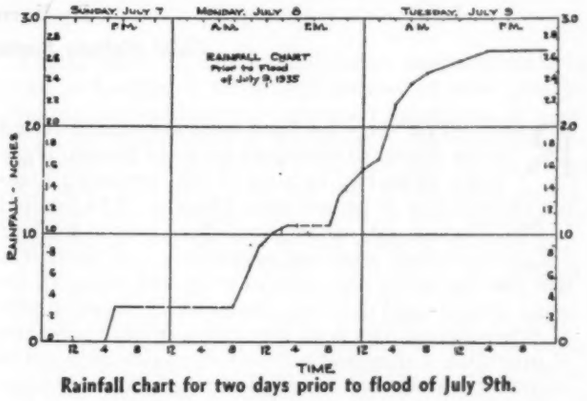


Standard section of box sewer.

Intake end of Trout Creek trunk sewer.

The trunk sewer having been designed, the branch line sizes were computed as shown on the study sheet. This line is of the average design—the 1-year frequency curve being used again, and a run-off coefficient of 0.50 throughout.

An interesting feature of this line is an interceptor grate and discharge line in a special manhole. This manhole functions in the normal manner with the exception of the interceptor grate and the 12" outlet therefrom. The purpose of this grate is to supply the residents on So. 5th St. (the old State Highway) with the spring water that they had always used for washing,



Rainfall chart for two days prior to flood of July 9th.

etc. inasmuch as there is no city water supply for them at the present time. Formerly, a small stream ran under the old highway, and down So. 5th St. in the rear of the homes on the west side of the street, and to maintain this flow, the interceptor was built. Under normal conditions, the spring water coming down the mountain side on the east of the highway enters the manhole, flows through the grate and thus keeps the stream supplied; but with the advent of a severe storm, the surplus water entering the manhole is carried down the main sewer; only the discharge of the 12" pipe flowing in the stream channel, thus preventing washouts and overflowing of the stream.

As with the trunk sewer, no trouble was encountered with the functioning of the branch lines due to the July flood, for at no time was there a flooded condition at any spot along the new highway.

In the near future, it is proposed to build another line up So. 5th to Emaus Ave. and this will eliminate practically the only remaining flooded street conditions of any consequence in this area.

The box section sewer was started on April 11, 1934 and was entirely completed by October 2, 1934.

The branch lines were started on May 9, 1934 and the work completed December 15, 1934. This work comprised sewers, inlets and some curbing. The balance of the contract, which consisted of curbing and sidewalk work only, was stopped during the winter months, but work was resumed this spring to complete the entire contract. This was done by July 22, 1935.

Left, an asphalt sidewalk on Boston Commons. Right, constructing a sidewalk along a 4-lane highway. Illustration shows the need for a walkway and also the simple equipment required for construction.

Sidewalks and Safety: Details of Construction

By Bernard E. Gray

Chief Highway Engineer, The Asphalt Institute

RECENTLY there has been much attention directed to the matter of sidewalks adjacent to rural highways, primarily because of the increasing number of fatalities to pedestrians, which in 1934 totalled 15,950. During this same year, there was a total of 337,810 accidents involving pedestrians, and while it is true that the larger part were in towns and cities, all too many injuries and deaths occurred on the roads outside of urban limits. The bold step taken in Massachusetts of providing a thousand miles of sidewalks adjacent to its state highways has forcefully brought home to engineers and public alike the fact that foot travel on a highway is hazardous, that the only real safe way is to separate the two kinds of traffic, and that sidewalks are required to accomplish this end.

But what kind of a sidewalk? What are the loads on a sidewalk; how wide should they be; how thick; of what material, etc.? Back in the bicycle days when the League of American Wheelmen was talking to Legislatures, a considerable mileage of cycle paths were built in the eastern states, and if memory serves correctly they were rarely over two feet in width. They were well graded, surfaced with fine stone or gravel, and set back from the roadway some six to ten feet. While road traffic was not so hazardous in those days, the smooth hard surface of the cycle path attracted pedestrian traffic in preference to walking on the road. It would seem then that the first need is to provide a reasonably smooth hard surface apart from the pavement, and to vary the width and thickness in accordance with local conditions. This means only a two foot wide footpath in some instances, with gravel or stone, or a bituminous treated soil surface, while in other locations a regular sidewalk four feet wide and of substantial character may be required.

Service History

The various combinations of asphalt lend themselves very well to this varying traffic condition, and particularly in regard to the work now being done by the several work relief agencies.

Asphalt sidewalks are not an innovation. They have been in successful use for half a century at least. A few of the present-day successful examples are cited:

The Commons—Boston, Massachusetts.
Lincoln Park—Chicago, Illinois.
City streets—Jackson, Tennessee.
City streets—Manchester, New Hampshire.
Park walks—New York City.
City streets—Mason City, Iowa.
Cornell University—Ithaca, New York.
White Plains, New York.
Wisconsin State Highways.

Design of Asphalt Sidewalks

The Asphalt Institute has recently completed a survey of sidewalk practice, receiving comments from city engineers in over 150 different municipalities. These comments have been very illuminating, ranging all the way from unfamiliarity with asphalt sidewalk construction, through criticism of results, up to complete satisfaction with pavements having long service history. The criticism has been of particular value in bringing out the difficulties encountered and pointing definitely to the need for adjusting design to the type of traffic found.

The most common criticism was to the effect that asphalt surfaces dried out and cracked because of insufficient traffic to keep the surface alive. One engineer pointed out that this cracking had occurred within a year or two after construction of the sidewalk, although the sidewalk was used for twenty years thereafter in this condition without much further deterioration. The second criticism was that asphalt sidewalks were moved out of place by tree roots, this of course being limited to areas where trees are found along city streets. Such criticism, however, would apply to any type of sidewalk regardless of composition and is capable of remedy only by periodic reconstruction.

A third criticism was to the effect that certain sidewalks had been heaved out of place by either moisture or frost, but analysis of design showed in each case that the foundation course did not exceed 2½ inches and that the subsoil was either clay or adobe. In no case where the foundation was four inches compacted depth or more had there been any movement of harmful character.

For the first criticism it is true that a sheet asphalt surface laid in accordance with specifications for heavy duty streets would undoubtedly dry out and crack within a very few years because this type is designed to utilize the kneading action of tires, and the amount and kind of asphalt employed is specified with this definite reaction in mind. Sheet asphalt sidewalks may be made quite satisfactory by using a softer asphalt cement and a greater quantity of it. The ordinary sheet asphalt specifications should be modified by substituting a penetration of somewhere between 60 and 100, the ordinary 85-100 penetration binder asphalt being satisfactory for the purpose. The per cent of asphalt should be increased approximately 1½ per cent over that used in adjacent city streets or else a seal coat of liquid asphalt and sand should be applied. Some comment has been made that this will result in a soft pavement which might bleed, but so long as a minimum stability of even 900 is had, such occurrence is quite unlikely. In any event, the application of approximately five to eight pounds per square yard of clean coarse sand during the final rolling will absolutely obviate any such development, while underneath the pavement will keep elastic.

The consensus of opinion favored the various coarse aggregate mixes, the reason being that a heavy film of asphalt of somewhat softer consistency is used, whether it is a penetration type or a cold-mix of some sort. Taking into consideration the present requirements in construction, especially in cities, it is probable that some sort of premix is to be preferred. If the city has its own municipal plant, either a sheet asphalt or an asphaltic concrete, modified as outlined above, will be found satisfactory. If the material is purchased from a contractor, it is probable that a cold premix material will be most desirable.

The foundation may be of stone, slag, cinders or gravel, watered and bound in place, and the thickness of wearing course should be somewhere between 1½ and 2 inches. A compacted thickness of 1¾ inches seems to be the one most used, and sufficient depth thus is had to take care of any minor variations in the subgrade.

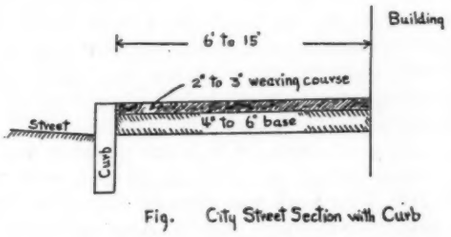


Fig. City Street Section with Curb

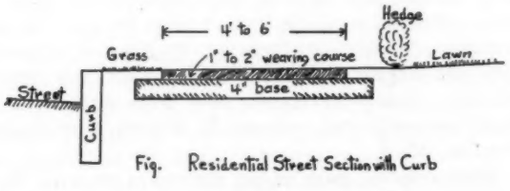


Fig. Residential Street Section with Curb

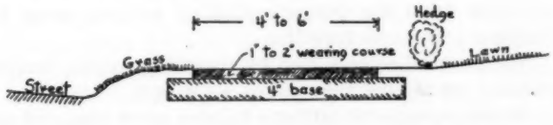
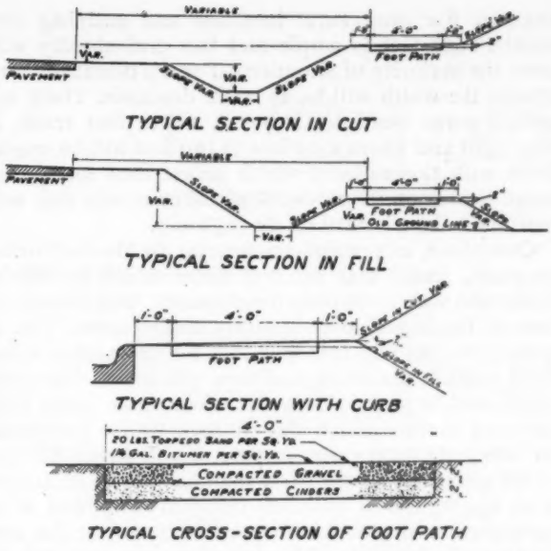


Fig. Residential Street Section without Curb

Sketches by the author of typical sections. These are from a forthcoming manual on the subject of asphalt sidewalk construction.



Foot Path Details, Wisconsin Highway Commission. Quantities per square yard are: Torpedo sand, 20 lbs.; bitumen 1¼ gals.; gravel, .0694 c. y.; cinders, .1389 c. y.

Furthermore, in using relief labor, cold-mix material can be handled to advantage because of more time for raking and compacting before set-up occurs. In addition, the bookkeeping is simplified as the usual practice is to buy the premixed material delivered on the site of the work at a fixed price per ton. Where good quality cinders are available, these make a very satisfactory foundation, and the cost seldom exceeds $1.00 to $1.25 per cubic yard, which makes them about the cheapest type of foundation to be had for city work. The compacted thickness rarely needs to be over four inches regardless of the kind of aggregate. Care should be taken to have a uniform quality, and raking of the material as it is placed will remove the oversized particles, so that uniformity is obtained. As a general procedure, it is desirable to have the base course extend from four to six inches outside of the asphalt wearing course. The earth shoulders can then be backfilled followed by seeding to grass where the sidewalk is in locations where this grass strip is possible. Where the sidewalk goes completely to the curb, the curb of course takes care of the lateral support.

Another type of surface for hand labor operations is the asphalt penetration macadam, in which case the wearing course should be approximately two inches in depth, thoroughly compacted by rolling, and followed by penetration with hot asphalt cement, a heavy naptha cutback asphalt or a quick breaking emulsified asphalt. Asphalt Institute Specifications cover this type of construction, except that the application of the asphalt will be made usually by hand pouring, or by manual spray nozzles.

For the least expensive surface and which is applicable to many roadway paths along rural highways, surface treatments may be employed. The foundation is prepared in the same manner as for the various types of road surfaces and the asphalt treatment can be made either by hand pouring or by a hose from the pressure distributor. The rate of application should be the same as for a highway, and the principal difference will be in the character of cover aggregate. Invariably the final seal should be of a coarse sand so as to obtain a smooth, dense, waterproof surface.

The width of sidewalks will vary according to the

location. For most rural locations and outlying city streets, four feet is ample and this undoubtedly will cover the majority of situations. For the downtown city streets, the width will be as traffic demands. There are certain rural locations, however, where foot traffic is very light and where a surface of two feet will be ample. Even with this reduced width pedestrians will be induced to stay on the sidewalk where otherwise they will continue to be a hazard on the highway.

One editor, in a recent comment on the Massachusetts' program, stated that but few states would be able to undertake such a complete development, both because of lack of funds and more sparsely settled areas. This is quite true, but also it is true that for these other situations a much smaller expenditure will suffice. The principal need is to provide a flat, clear space apart from the road surface which may be used by the pedestrian in safety. If only a dirt surface, it will suffice for part of the year, and for the rainy seasons, light stabilization with aggregates or asphaltic materials employed as an admixture will provide adequate surfaces for the very light traffic locations. The quantities involved are not large; for a three foot walk and an application of one gallon per square yard for soil stabilization, the total would be less than $300 a mile.

Crown

The sidewalk should slope toward the road surface, whether a curb is used or not, and the usual amount is ⅜ inch to the foot. The only exception is for parks, where the crown is made each way from the center of the walk, although the rate is the same. This is somewhat greater than for a road surface, but it is desirable to have the surface drained very rapidly. The same crown applies to the earth shoulder as to the sidewalk surface itself.

As in road design, the selection of type of surface should be made in view of the traffic requirements. All too often there has been overdesign in sidewalks, and the high cost has led to their omission as a part of the highway development, with consequent loss of life to the pedestrian. After all, the matter cannot be dismissed with the statement that sidewalks cost too much, because it is the duty of the engineer to provide the necessary facilities and to work out a design which will come within the funds available. There is no point in placing a 2″ premix top if a surface treatment at one third the cost will do the work, nor in doing anything but placing a totally untreated surface if that will suffice. But there are many miles of streets and highways where substantial foot traffic is found, and in such cases a sidewalk or footpath would appear in order, to a much greater extent than exists at present.

Does Snow Removal Pay?

No survey has been made to determine the increased return from the gasoline tax, or the increase in local business through open winter roads. I believe there is a material return due to winter maintenance, which keeps the roads open for normal business plus the increasing use due to winter sports in New Hampshire. We endeavor to plow the snow as far from the travelled way as possible, so that in melting, the water will run in the ditches. This materially reduces our spring maintenance work, especially on the surface-treated gravel roads.—*F. E. Everett, Commissioner, New Hampshire State Highway Department.*

Does snow removal pay? It is impossible to answer this question in dollars and cents. I do not think there is any doubt that it does pay, but the benefits are so far-reaching and intangible that I see no way to reduce them to figures.—*R. H. Baldock, State Highway Engineer, Oregon.*

We have no figures to show how much more gasoline tax we received on account of the roads being plowed, since snow removal in this State started gradually and has increased each year. There is no question but what snow removal pays, as there is a large amount of travel during the winter and the towns plow about 2904 miles of State Aid roads on which the State pays 50 per cent of the cost. This is in addition to the 1000 miles plowed by the State last winter.—*H. E. Sargent, Commissioner, Vermont Department of Highways.*

Snow removal, in my opinion, pays some slight returns in lowered maintenance costs, saving culverts filling up and overflowing road beds. Increased business is a small factor and varies with density of population the roads serve.—*Howard C. Sword, County Engineer, Richland Co., Ohio.*

I have no definite opinion of the dollars and cents returns from snow removal, but I do know that it pays simply to get the water off the roads, to say nothing about helping business conditions.

If DuPage County did not remove the snow we would not have jobs very long. We clear all of our roads, beginning with the state highways and working through to the secondary roads. The doctors and undertakers know that we will take care of any emergency and we try to open the roads for funerals, to cemeteries, and where there is sickness. I believe snow removal is one of the best services for any community.—*Eugene F. Yates, Superintendent of Highways, DuPage County, Illinois.*

We do not have any definite way of knowing what effect snow removal has on spring maintenance costs, as no particular difference has been noted on streets where we removed snow as compared to those where we do not remove snow.

There is no doubt that it does increase business and improves the feelings of our citizens where streets are kept open and free from accumulation of snow and slush. We only remove snow from the principal thoroughfares and business streets, but do plow snow to curb line on principal residential streets during heavy snows or drifts. Many requests are received to remove snow from additional streets, which have to be denied due to lack of funds, equipment, and man power.

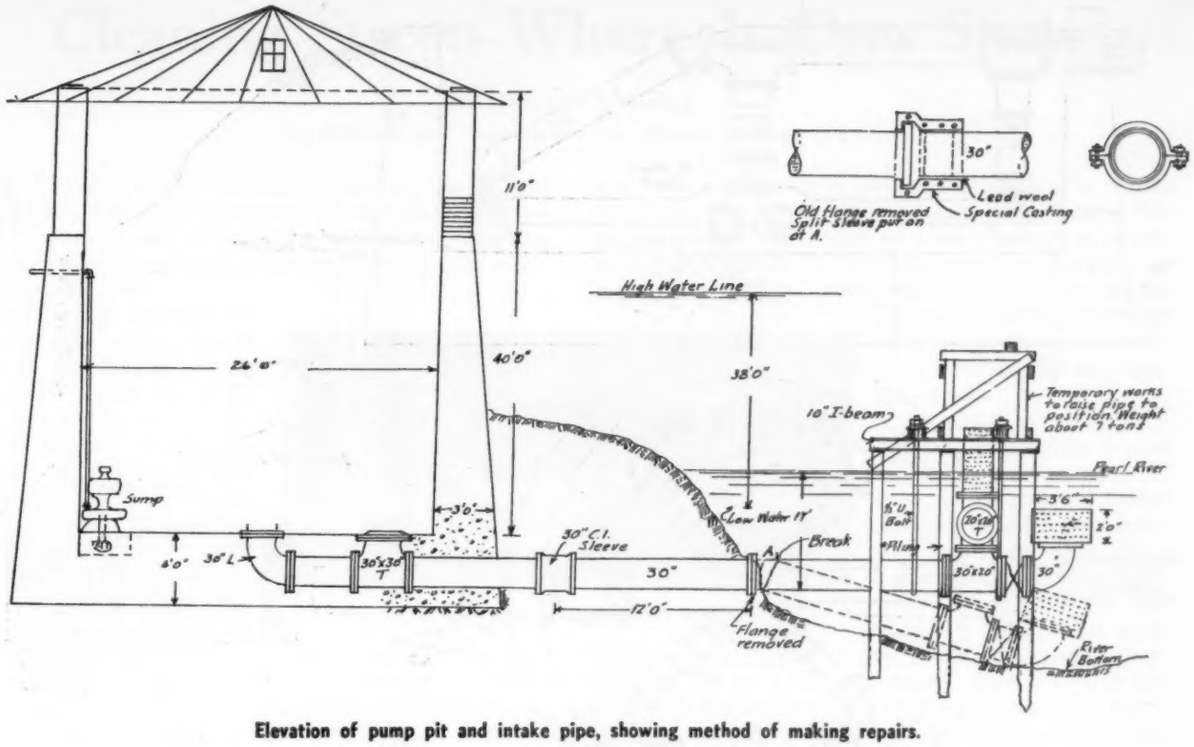
During the year 1934, 1620 hours of labor was required in the removal of 2122 cu. yds. of snow at a cost of $1,766. This work was done on approximately 5 miles of principal business streets. Approximately the same amount will be done this year. We do plow sidewalks after snow of one inch or more because the public demands this service; however, we are not supposed to give this service, as there is a City ordinance requiring property owners to remove snow from walks which has never been enforced.—*Lewis M. Wrenn, City Engineer, Pontiac, Mich.*

Snow removal pays us big returns at present. We haul all snow from the business district, making room for parking autos and traveling.

We plow all streets used by traveling public, thereby making people use their autos all winter.

Business men are anxious to have snow removed and want speedy service.

Maintenance in spring is lowered, but is increased during the winter due to plowing the snow in the gutter line and thaws will not flow to catch basins.—*John H. Barth, City Engineer, La Crosse, Wis.*



Elevation of pump pit and intake pipe, showing method of making repairs.

Ingenious* Repairing of a Waterworks Intake

By J. H. Fewell

(Superintendent, Jackson, Miss., Water Dept.)

AT SOME time during the summer of 1935 (the exact date is not known), the thirty-inch intake main that supplies water from Pearl river to the low-lift station of the Jackson, Miss., water works broke. This intake was well screened, and when fish and eels began to give trouble by clogging the motor-driven centrifugal pumps an investigation was made and disclosed the fact that the intake main had broken very close to a flange (shown at A in the drawing) just outside the river bank, and had dropped to the bottom of the river, leaving a 7-inch opening at the top of the pipe, through which the fish and eels had entered.

The Author

Plans were made immediately for making repairs without interrupting service. Six creosoted piles were driven, three on each side of the pipe, near the extreme end, to support steel I-beams, from which two 1½ inch U-bolts were suspended to hold the pipe permanently when it had been brought back into position by chain hoists, which were suspended from a temporary structure erected on top of the I-beams.

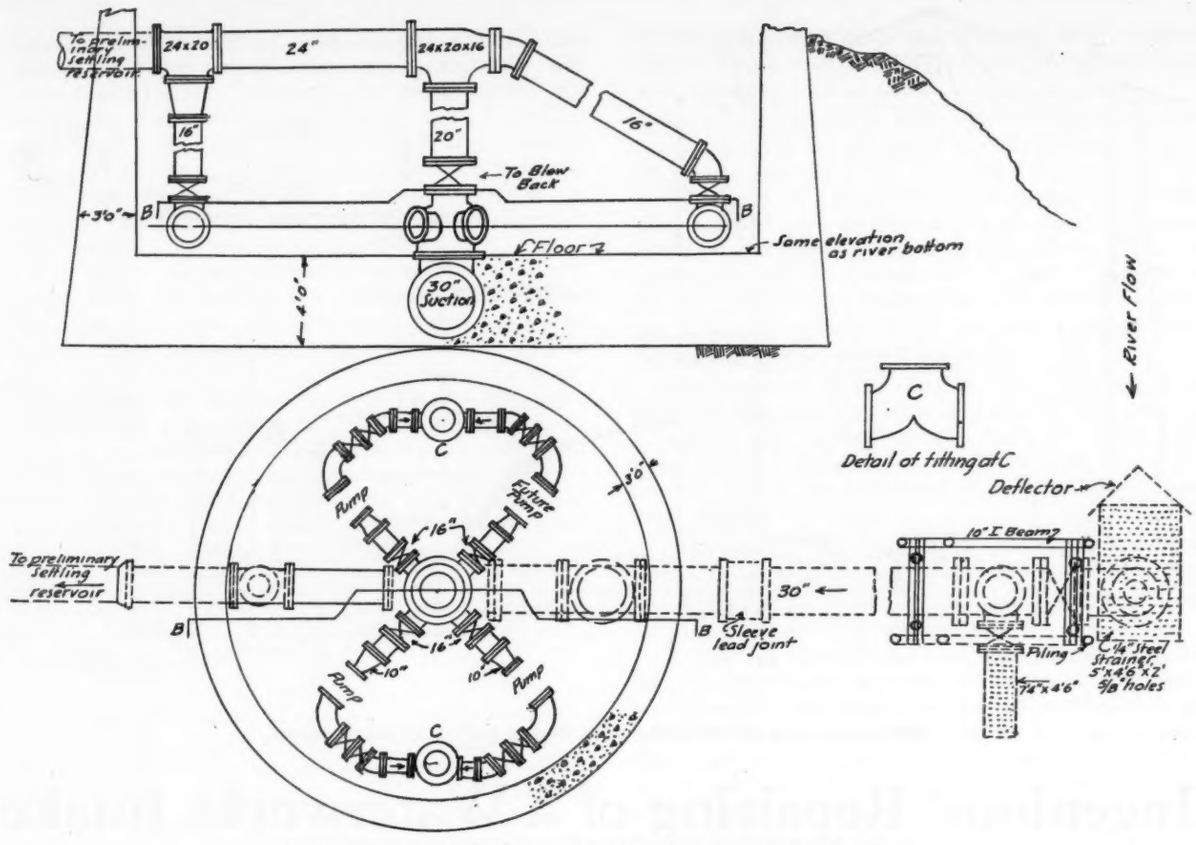
When the pipe and screens were back in position, repair was made by under-water work, the water here being about 11 feet deep. There being no diver or diver's equipment available, two divers' helmets were improvised. Small galvanized trash cans, large enough to go inverted over the heads of the men, were so placed and tied down to their belts. Clips were soldered to the inside and outside of each can so that a ⅜ inch hose could be passed through them down the outside and up to the top on the inside; which hose extended to a platform above the work and was connected to a good automobile pump, which furnished air to the inside of the can. Weights were attached to the men's belts to hold them down. After some experimenting, we found the men could remain under water comfortably for ten minutes or more.

After the pipe with its screens had been lifted into its original position, the broken flange was removed, and an especially designed cast-iron split sleeve was lowered into place with the lip hooked over the good flange, the two halves were bolted together with 1¼ inch bolts, and the opening between sleeve and pipe was calked with lead wool.

The other sketch shows the piping layout in the circular pit of the low-lift pumping station, which is an interesting bit of successful engineering and, as far as information at hand goes, is the smallest space in which four 4 m.g.d. pumps of such size can be installed. Standard cast iron fittings were used throughout. We do not think the plan could very well be improved on, as almost any piece of the work could be replaced without interfering with the operation of the other pumps, which operate against a head of 70 feet. A similar one has been built in Tokio, Japan, which was copied from this plan by two Japanese engineers who came to this country to inspect the layout.

One of the advantages of this installation is its ability to blow the entire seventeen hundred feet of pipe line back to the river by opening the 20-inch valve located above the six-way cross. Two of these pumps were

*The editors, not Mr. Fewell, are responsible for this title.



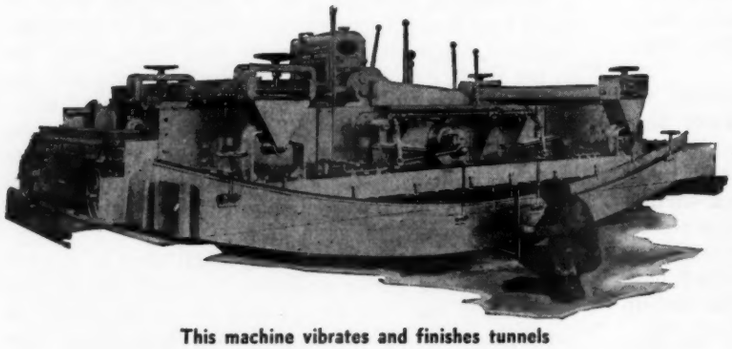
Plan and elevation of circular pump pit. Also plan of screened intake pipe.

installed in 1914 and the third in 1925, leaving room for the fourth and larger, if necessary in the future.

Owing to the small space and circular construction, it was quite a problem to work out a plan that would accommodate the four pumps and leave room enough to remove the rotors from the motors, which is sometimes necessary. How well we succeeded is shown by the years of successful operation without one minute's interruption. Quite a number of engineers have visited our plant and been much impressed with the layout.

A Finisher for Large Tunnels

In building the metropolitan water system between the Boulder Dam and Los Angeles, construction of the invert in the large tunnels called for mechanical finishing and vibration of the concrete. This necessitated a type of finishing machine not previously available, but a variation from a standard road finisher was developed for the purpose and three such machines now are in use on this work by Thompson-Starrett Company, the Barrett-Hilp and Macco Corporation, and the Griffiths Company. One of these machines is equipped with electric vibratory motors on the front screed together with an independent motor generator set for furnishing the current.



This machine vibrates and finishes tunnels

The machine illustrated in the photograph is set for 20 ft. width, the screed having a negative crown of 17" and being entirely supported by the machine itself by means of cradles so that no portion of this weight rests on the forms.

The design of the conduit was such that within short intervals there was necessity for changing the width of the machine from 20 ft. to 28 ft. and this was accomplished by telescopic members in the machine itself so that this change might be made in approximately two hours. The screed remained the same and the additional width was roughly finished by a strike-off plate, which carried a shoe which cut, in this additional width of concrete, a keyway to bond it to the wall of the tunnel to be built later.

The power plant and driving mechanism was the same as used in the standard Jaeger-Lakewood road finisher, with the structural changes necessary to accomplish construction results in accordance with the specifications. Very satisfactory results have been obtained with this finisher, although exceptionally harsh, dry concrete was used.

Cleaning Streets Where It *Does* Snow

By George C. Stanley
City Engineer and Superintendent of Streets, Burlington, Vt.

WITH us who live in the northern section of Vermont there is no question whether snow removal pays or not. It would be impossible for traffic and business to continue during the winter months without snow removal.

The average snowfall per year in Burlington, according to the United States Weather Bureau station in this city (which record covers a period of fifty-one years), is 66.3 inches. Our snowfall for the winter 1934-1935 was 75.1 inches.

What snow does to Burlington's streets

Our snow removal costs average about twenty-five per cent as high as our normal maintenance cost for paving. It is our opinion that the removal of snow and ice, which prevents the forming of ruts which in turn cause serious damage to the lower type pavements, especially when chains are used on the tires, helps to lower the spring maintenance cost on our streets and pavements. Prompt snow removal always tends to increase local business.

We have been requested by numerous property owners living in unaccepted streets (private developments not deeded to the city) to plow their streets after each storm. This request has always been granted, although it is the opinion of the city attorney that the expenditure of tax money on privately developed streets not deeded to the city is unlawful. The street commissioners feel that there is a moral obligation to the people living on streets developed privately because their taxes go into the city treasury regardless of whether the street is accepted by the city or not.

The city has sixty-three miles of streets all of which are plowed after every storm when the snowfall is two inches or more. We also plow all sidewalks, starting the plows at 4:00 A. M. and taking approximately four to five hours to complete the entire sidewalk system, which included approximately 120 miles of sidewalk, a large percentage of which are paved. Any storm of less than two inches in depth is not plowed but the abutting property owners are obliged to clear their own walks within a reasonable time after the snow ceases to fall. All street plows start plowing as soon as the depth has reached two inches, no matter what time of day or night this may be, and continue their work until the job is completed.

The city is situated on a side hill overlooking Lake Champlain. It starts from the shore of the lake at an elevation above sea level of approximately ninety-six feet, and the streets running easterly from this point have grades varying from 3 or 4 per cent up to as high as 17 or 18 per cent, and have a total rise in elevation of about 274 feet at the University of Vermont campus, which is approximately twelve blocks east of Lake Champlain or approximately one mile. With such steep grades you can readily see that we would have considerable trouble during icy times, especially at intersections where traffic is controlled by stop-and-go signals.

George C. Stanley

In order to avoid accidents during the icy period and after sleet storms, we use calcium chloride mixed with our sand for light coatings at all important intersections and all traffic light intersections. We also use rock salt mixed with sand for the same purpose and have found both of them very effective. We use a "Handy Sandy" sand spreader for spreading the mixture, but also do considerable hand work, as one machine will not cover our mileage fast enough.

We also have inaugurated a system for sanding our sidewalks and cross walks which has met with ready approval by the public and which we feel has been very satisfactory. We have built one hundred wooden boxes which hold approximately one cubic yard each. These boxes are made water-tight and are filled with sand which has been thoroughly dried by running it through our asphalt plant rotary drier. A quantity of this sand is stored for additional supply after the boxes have been filled and a small truck inspects the boxes every day during the icy times and replenishes the sand as it is used from the boxes. The sand in these boxes is not only used by city employees for the main walks and cross walks, but the Street Department encourages the citizens to form the habit of using this sand for sanding their own sidewalks in front of their property and for sanding any private walks or driveways on their premises. Very often we see people drive up to one of these boxes and fill a pail or basket with sand and drive away to his home. This service is very much appreciated and costs very little comparatively.

Our snow removal equipment includes one Sargent V Type tractor plow, one Ross heavy-duty truck plow mounted on a seven-ton White truck, one heavy-duty truck-type Good Roads blade plow mounted on a two-ton International truck, one Baker blade plow mounted on a three-ton Reo truck, one Good Roads blade plow mounted on a two-ton Dodge truck, one Handy Sandy, 12 V-type horse-drawn wooden plows for plowing sidewalks.

We also rent additional truck equipment for hauling snow from the business streets. All snow hauled off the streets is loaded by hand into the

trucks and dumped into Lake Champlain. We have never added a snow loader to our equipment because of the great number of men available during the winter months who are out of work or on the charity rolls. I would much prefer a snow loader and know that it would be far cheaper for us than employing hand labor, but the unemployment situation has seemed to overbalance the amount of money that might be saved by using equipment.

Oiling and Retread Surfacing in California

It has been evident during the past few years that funds would not be sufficient to provide for reconstruction of the older pavement surfaces on California highways before a considerable mileage became so broken and rough as to seriously inconvenience traffic. With this problem in mind, considerable study has been given to the development of a comparatively thin type of surfacing, at a reasonably small cost, which would serve to smooth up and seal broken surfaces and at the same time have stability and carrying power.

For this purpose the so-called "retread" surface, as finally developed, is used, consisting of an application of from 100 to 125 pounds of 1¼" to ¾", or 1" to ½" crushed rock, depending on the thickness desired, road-mixed with 0.5 to 0.7 gallon of the mixing type of emulsified asphalt per square yard of surface. This application is bladed into place and rolled. After the mix has set, key rock, ½" to ¼", is spread at the rate of from 10 to 20 pounds per square yard and the surface rolled and broomed until the voids are filled and any excess uniformly distributed. As the second application, penetration type emulsion is spread at the rate of from 0.2 to 0.3 gallon per square yard and immediately covered with fine screenings, ⅜" to No. 10 mesh, at the rate of 10 to 18 pounds per square yard and the surface broomed and rolled. Before the next application, the surface is checked for ruts or other irregularities and necessary smoothing taken care of by patching. The third application is not made until the work has been completed and under traffic for several days.

For the third application the surface is thoroughly cleaned with power brooms and a penetration type emulsion is spread at the rate of 0.2 to 0.3 gallon per square yard of surface and immediately covered with fine screenings at the rate of 8 to 12 pounds per square yard. As soon as the screenings have set sufficiently in the emulsified asphalt, the surface is broomed to distribute them evenly and rolled with an 8-ton roller.

The cost of this type of work varies from $4,000 to $5,000 per mile for a course of 1¼" to 1½" compacted thickness.

Moisture which reaches the subgrade and impairs the bearing power of the soil is the great enemy of the bituminous macadam or oil treated type of surface. In order to ascertain if leakage occurs in a given section of road, permeability tests are made. Whenever such tests show that the oil surface takes up water to any appreciable extent, the surface is sealed, using the MC3 cut-back asphalt or emulsified asphalt at a rate of 0.2 gallon per square yard of surface and screening with 10 pounds of sand per square yard. Where the surface is of open coarse texture, the treatment is varied to provide one-quarter gallon of asphaltic road oil, either hot or emulsified, contatining 90-95 per cent of 80° penetration asphalt, screened with 25 pounds of rock screenings per square yard and rolled.

In addition to the application of oil as a dust palliative, about 300 miles of State highway has been mixed or remixed. The mix type of treatment requires from one gallon to one and one-half gallons of 60-70 or 70-80 per cent asphaltic oil. This type of work is more adaptable to the desert and similar dry areas where the native material is suitable. An oil cake from two to four inches in thickness is produced, which, with a light seal coat, provides a smooth, dustless surface of a more enduring character than the dust oil application.

The above information is from the report of the Division of Highways of California.

Not "Slippery When Wet"

EDITOR, PUBLIC WORKS MAGAZINE,
DEAR SIR:

I note an article in the PUBLIC WORKS for November, 1935, entitled "This Road Slippery When Wet," by Samuel Eckels, former chief engineer of the Pennsylvania Department of Highways and now chairman of the Allegheny County Authority.

While I am sure that Mr. Eckels in writing this article was concerned primarily with the matter of pointing out the responsibility upon highway administrators to so carry on maintenance work that warning signs "Slippery When Wet" might be eliminated, there is the inference that the way to obtain a non-skid surface is to use tar. While I am sure that this was not the intent and, as the article as a whole is excellent (as would be expected from a man of Mr. Eckels' long experience) I am taking the opportunity to supplement his comment with a brief discussion of this subject.

Several years ago, when in one of the western states, the writer attended a meeting of engineers when this same matter of safety was being discussed, and the state engineer told the assembled division engineers that the presence of a sign on a state highway, "Slippery When Wet," was not so much a warning to the public as it was an admission by the state engineers that they did not know how to make a road that would not be slippery under such conditions. He further stated rather pointedly that he expected to see such signs removed and that the road surfaces would be of a texture equally able to give satisfactory traction when wet as when dry. With Mr. Eckels and with this western engineer there can be no disagreement that it is the duty of a highway administrator to see that, except for conditions of ice and snow beyond control, there shall be no need for such warning signs. I agree further with Mr. Eckels in regard to the old fallacy that asphalt and tar cannot be used in the construction of the same road; and while he comments on the use of tar on an old asphalt pavement, it might equally well have been the use of asphalt upon an old tar road with equally satisfactory results. The important point to be stressed is the correct relation between the aggregate and the bituminous material employed, rather than the bituminous material itself.

Professor Moyer of the Iowa State College has brought out so completely the fact that asphalt pavements may have the very highest coefficients of friction, that it is hardly needful to go into this aspect of the matter. The amount and kind of traffic should also be taken into consideration, for it has an important bearing on the matter of granular surfaces. For example, a retreatment on a macadam road having only 500 vehicles per day could be accomplished with approximately 1/3 gallon of bituminous material and 25 pounds of aggregate, whereas if this retreatment were to be done upon a road having 2,500 vehicles a day the 1/3 gallon application should be covered with 35 to 40 pounds of aggregate because the increased volume of traffic tends to make the bituminous material cover a greater area, whereas under fairly light traffic a somewhat greater quantity is required to hold the aggregate in place.

Another important consideration is the rate of curing of the bituminous material. With the high speed traffic of today, it is essential that as soon as the aggregate is rolled into place, the curing of the bituminous material shall be sufficiently fast to retain the aggregate so that it will not whip off the road surface. This again calls for an evaluation of traffic volume and the proper size of aggregate to meet a given condition. The coarser the aggregate, the more rapid the curing and the higher the viscosity required. It is for this reason that the rapid curing asphalts have been so successful for this purpose.

The foregoing is not written in any spirit of criticism of the article, but rather to emphasize the fact that the non-skid surfaces may be obtained just as readily by the use of appropriate grades of asphaltic material as by the use of tar, which fact has been thoroughly brought out by research studies.

Very truly yours,
BERNARD E. GRAY,
Chief Highway Engineer.
THE ASPHALT INSTITUTE.

The Editor's Page

SUMNER W. HUME

It is with deep sadness and grief that we announce the death of Sumner W. Hume, who passed away Sunday, November 17th.

Mr. Hume was the president of this organization from 1910 until his retirement a few years ago because of a weakening of the heart which finally carried him away, in his 76th year.

His experience in the publishing field began in 1888, when he joined the staff of "Power." Mr. Horace M. Swetland, the publisher of that journal, said that Mr. Hume was a born salesman. In a remarkably short time he began to bring in orders, and in a few years he was made a vice-president and western manager with offices in Chicago. He sold advertising from Minneapolis to Pittsburgh and was recognized by the advertising fraternity of that time as a star salesman.

After he became president of PUBLIC WORKS he attended all conventions of organizations concerned with public improvements and was well known by the most important advertisers in that field in all parts of the country. He will be remembered by them as an earnest and affable salesman.

He possessed the happy faculty of making friends and few men in the publishing field were so widely known as he among both the advertising managers and the manufacturers themselves. He was a good mixer—always at home in any crowd. He was famous for his funny stories; he never forgot a good one and was able to tell one to fit almost any occasion.

He was big hearted, generous, and emotional; nothing within his power was too good, or too much trouble, for his family and his friends.

His chief diversion was fishing and he was an adept at angling for game fish. For more than twenty years he spent a month of each year fishing in the Northern Wisconsin lakes, and in later years in certain Canadian lakes where he caught his share (or more) of "muskies," the tigers of fresh water fish. It was a real delight for him to surprise his friends by sending them a "musky" weighing from 15 to 30 lbs., so carefully packed with ice and moss that it was fresh and sweet when delivered.

To us who were intimately associated with Mr. Hume, in both business and social life, his place will never be filled.

Lesson for Engineers From the Depression

"I trust that out of the PWA and the semi-constitutional activities carried out under other series of initials the engineer has learned something of the necessity for advance planning of public works, of the necessity for sound economics as well as sound technique, and of the advantages and disadvantages which might result from a Federal Public Works Department." Thus Carey H. Brown, superintendent of engineering of the Kodak works, to the Rochester Engineer Society.

The wise man learns more from adversity than from prosperity, and it is to be hoped that the engineering profession will prove their wisdom in this respect. They certainly have had plenty of adversity to learn from.

Take only the matter of advance planning. Three years ago PUBLIC WORKS urged public officials to prepare at once plans for needed public work, complete with detail plans and specifications; but a large part of the delay in starting PWA work was due to the failure of officials, for weeks and months after the offer came, to present complete plans and estimates in their requests for funds.

There may not again be just such a need for ready-prepared plans, but others will arise. A common one is a sudden demand by city council that the city engineer prepare plans for a certain project to be presented at the next meeting. To prepare adequate, carefully considered plans in that time may be impossible. But if the engineer has not already prepared such plans in anticipation of such demand, he has the alternative of presenting half-baked plans or pleading for more time. Too often he chooses the former for fear the latter will be considered a confession of lack of ability. But if not lack of ability, it is frequently lack of prudent foresight and preparation.

Geography in Engineering

Engineers learn more from the experience of other engineers than from their own—or at least they should, for the former is so vastly more comprehensive. But that does not involve blind copying of methods. Because a Maine water superintendent puts his mains 7 feet under ground to prevent freezing, or a New York sewage works collects gas from the digestion tank to use in heating said tank in winter, is no argument for Florida to do the same. And an asphalt paving mixture that is best for Canada would give poor service in a warm climate, and vice versa. Reference to the last will be found in this issue; to the effect of temperature on sewage treatment in our next one.

Rainfall Records for Planning Storm Sewers

Based on a Study of Twenty-eight Thousand Records of Storms During Thirty-three Years

AS STORM sewers and drains are provided for the purpose of removing rainfall, calculation of the size must be based upon the amount of rainfall to be removed. There are three major considerations: 1st, what frequency class of rainfall is to be removed—the maximum ever to be expected, or those expected once in two, five or ten years, or other intervals; 2nd, the probable rate of rainfall of that class during 5 min., 10 min., etc., periods; 3rd, the percentage of such rains flowing off immediately.

The all-time rainfall may be approximately double the maximum occurring at 5-year intervals; and the latter 25% to 50% more than the 2-year maximums. To build the capacity needed for the first class would involve a capital cost, a considerable part of which would render no return for fifty to one hundred years, the interest on which would pay for the damages caused by flooding of streets and properties several times because of gorged sewers. Without discussing this point further it may be said that it is a more or less common practice to provide for the maximum storms to be expected at ten-year intervals (or rather, ten times in 100 years—no class of storms recur at uniform intervals). Special conditions may of course give reasons for adopting shorter or longer intervals in a given case.

The run-off percentage, also, is a problem in itself. This article will deal only with rainfall rates.

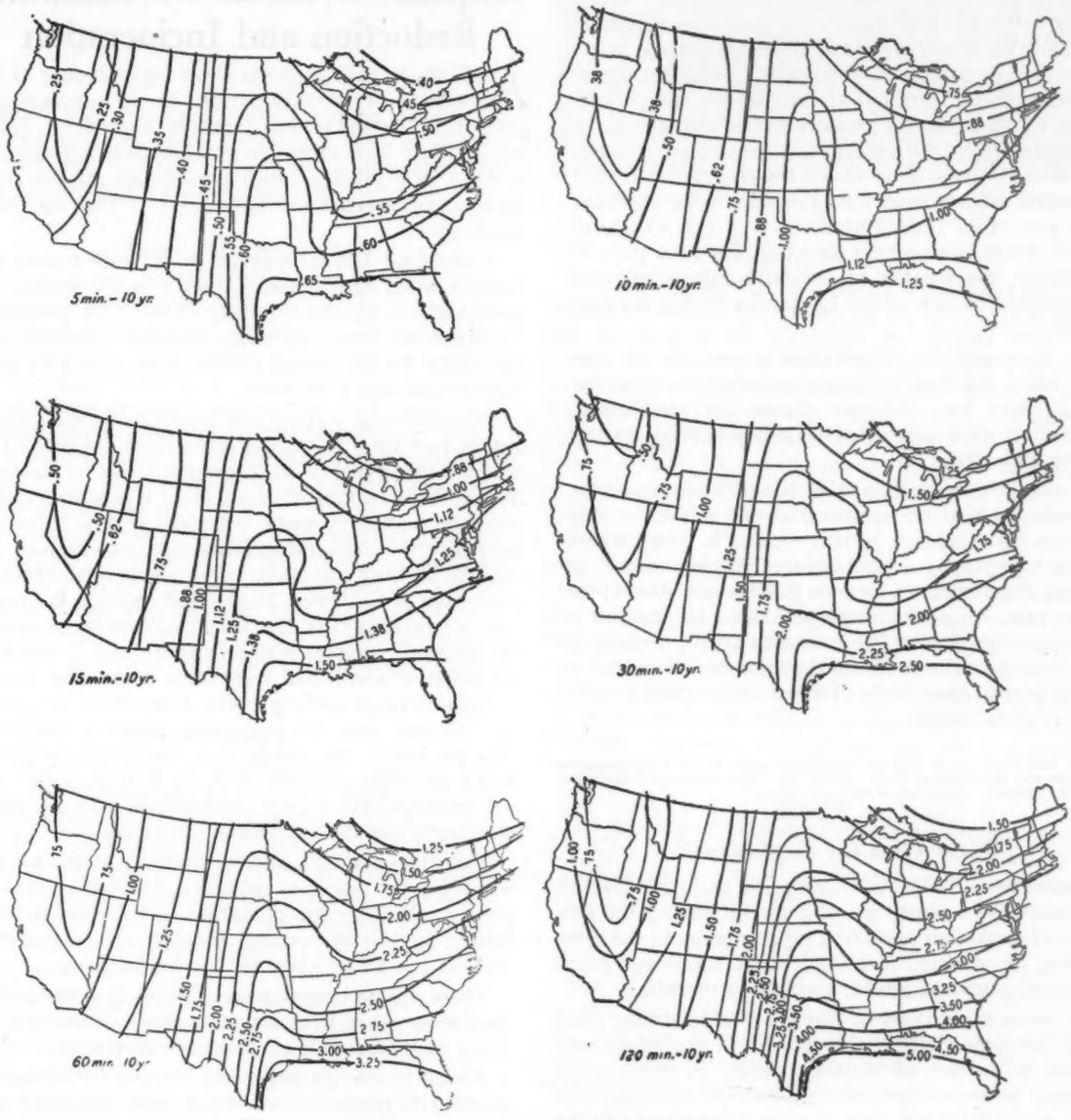
Estimation of rainfall rates must, it is thought, be based upon records of past rainfalls. The common practice has been to use records taken in or near the city in question; but "many recent researches have demonstrated that, as a basis for the design of improvement works, conclusions respecting the probable intensity and frequency of rainfall in a given area are far safer and more economical if drawn from a study of the occurrences at many stations than if drawn from 25- or

Maximum Rates of Precipitation at Individual Stations, Through the Year 1933
Precipitation in Inches During Number of Minutes Stated

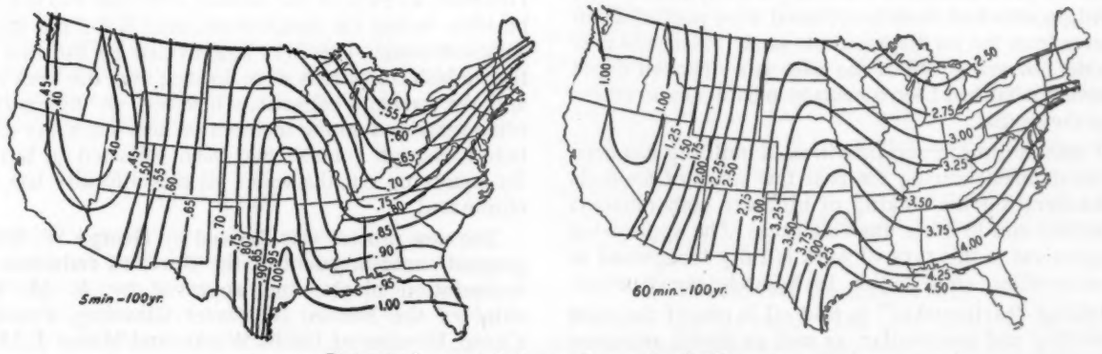
Station	*5*	*10*	*15*	*20*	*25*	*30*	*40*	*50*	*60*	*120*
Portland, Maine	1.06	1.41	1.52	1.56	1.64	...	...	...	...	1.97
Concord, N. H.	.55	1.06	1.55	1.88	2.18	2.39	2.69	...	...	...
Northfield, Vt.	.85	1.46	1.64	1.71	1.74	1.80	1.91	...	...	2.28
Boston, Mass.	.56	.90	1.07	1.29	1.41	1.45	1.54	1.63	1.76	2.41
Nantucket, Mass.	.42	.69	.81	.99	1.18	1.34	1.68	2.19	2.31	3.00
Providence, R. I.	.41	.76	1.09	1.29	1.47	1.59	1.78	2.10	2.46	...
New Haven, Conn.	.78	1.27	1.77	2.26	2.32	...	...	...	2.37	...
New York, N. Y.	.68	1.20	1.63	1.93	2.14	2.31	2.46	...	...	3.50
Trenton, N. J.	.56	.94	1.13	1.43	1.62	1.69	...	...	1.70	...
Reading, Pa.	.59	.98	1.39	1.74	1.92	2.05	2.20	2.42	2.68	4.89
Baltimore, Md.	.74	1.39	1.90	2.23	2.52	2.69	...	...	...	3.38
Cape Henry, Va.	.70	1.25	1.80	2.13	2.46	2.79	3.42	3.50	3.67	...
Parkersburg, W. Va.	.67	1.14	1.52	1.68	1.76	1.91	...	...	...	...
Hatteras, N. C.	.61	1.21	1.72	2.20	2.61	3.04	4.07	4.96	5.26	...
Charleston, S. C.	.56	1.02	1.48	1.87	2.16	2.36	2.77	3.51	4.08	6.62
Thomasville, Ga.	.71	1.26	1.83	2.27	2.66	2.99	3.36	3.77	4.14	...
Pensacola, Fla.	.80	1.53	2.29	2.88	3.37	3.65	3.94	4.15	4.27	6.10
Detroit, Mich.	.78	1.37	1.81	2.06	2.21	2.36	2.51	2.60	2.98	3.86
Madison, Wis.	.55	1.08	1.37	1.61	1.88	2.09	2.64	3.19	3.64	...
Toledo, Ohio	.60	1.19	1.76	2.18	2.61	2.88	3.26	3.46	3.58	...
Terre Haute, Ind.	1.05	1.32	1.38	1.56	1.70	1.80	2.18	2.46	2.57	3.13
Springfield, Ill.	.59	1.02	1.41	1.67	1.92	2.10	2.42	2.70	2.75	...
Lexington, Ky.	.66	1.13	1.54	1.83	2.10	2.34	2.85	3.09	3.20	5.15
Chattanooga, Tenn.	.80	1.23	1.51	1.77	...	1.85	2.30	...	2.52	...
Mobile, Ala.	.73	1.33	1.54	1.89	2.22	2.31	...	2.62	3.02	4.47
Meridian, Miss.	.67	1.05	1.52	1.90	2.15	2.36	2.73	3.06	3.63	...
St. Paul, Minn.	.58	.98	1.33	1.69	1.90	2.12	2.31	2.41	2.60	3.04
Devils Lake, N. Dak.	.90	1.45	1.84	2.18	2.24	2.40	2.64	...	2.70	...
Huron, S. Dak.	.76	1.14	1.47	1.74	1.89	1.98	...	...	2.12	...
Sioux City, Iowa	.75	1.31	1.75	2.18	2.61	2.71	2.81	...	2.94	...
Valentine, Neb.	.75	1.37	1.87	2.14	2.34	2.52	2.74	...	3.01	...
Kansas City, Mo.	.80	1.12	1.65	2.15	2.65	3.07	3.79	4.32	4.74	...
Topeka, Kansas	.66	1.07	1.38	1.74	1.98	2.21	2.69	3.02	3.27	3.82
Bentonville, Ark.	.64	1.19	1.45	1.62	1.72	1.84	2.13	2.21	2.31	2.95
Oklahoma City, Okla.	.60	.91	1.43	1.74	2.00	2.29	2.65	2.80	3.08	...
New Orleans, La.	.75	1.19	1.68	1.97	2.23	2.37	2.59	3.22	3.66	5.64
Taylor, Texas	1.90	...	2.30	2.75	2.83	2.89	2.97	3.58	4.22	7.51
Miles City, Mont.	.38	.62	.81	.98	...	...	...	...	...	...
Cheyenne, Wyo.	.48	.90	1.32	1.63	1.92	2.04	2.32	...	...	...
Yellowstone Park, Wyo.	.17	.30	.31	.39	.45	.50	...	...	...	...
Lewiston, Idaho	.30	.50	.65	.80	.95	1.05	...	...	...	...
Denver, Colo.	.87	1.20	1.52	1.62	1.67	1.72	...	1.93	2.20	...
Modena, Utah	.38	.68	.95	1.06	...	1.12	1.22	1.27	1.41	...
Winnemucca, Nev.	.27	.53	.71	.79	...	...	...	...	...	...
Roswell, N. Mex.	.55	.86	1.17	1.33	1.37	1.46	1.70	1.92	2.21	2.78
Phoenix, Ariz.	.36	.60	.81	.99	1.11	1.16	1.28	...	1.30	1.79
Seattle, Wash.	.29	.46	.51	.57	...	.58	...	...	...	...
Roseburg, Oregon	.55	.80	1.10	1.14	...	...	...	...	...	...
Mt. Tamalpais, Calif.	.19	.34	.40	.45	.50	.53	.65	...	...	...
Fresno, Calif.	.34	.58	.82	1.06	1.12	1.16	...	...	...	...

50-year records from only one station. Single-station records seldom, if ever, give a correct picture of the normal rainfall experience in any particular area. The charts presented herewith are based upon the weighted rainfall experience of all Weather Bureau stations, and therefore are more dependable for design than the records of any individual station. However, since heavy rains are local phenomena and subject to local influences, especially in mountainous regions, the intensity-frequency charts shown are recognized to be, as predictions of future occurrence, probabilities rather than absolute certainties."

The above is quoted from a pamphlet issued a few weeks ago by the U. S. Department of Agriculture,



Rates to be expected once in ten years



Rates to be expected once in one hundred years

Isohyetals (lines of equal precipitation) showing maximum rates of rainfall for different periods of time.

The period of time for each chart is given in its lower left-hand corner

prepared by David L. Yarnell, senior drainage engineer in that department and based upon a detailed study of the records of 28,077 excessive short-time precipitations at the 211 Weather Bureau stations in continental United States having recording rain gauges, up to the end of the year 1933.*

For a few States, 33-year records were used; for some, 24½-year, and for the others, the 20-year records covering 1914-33. Two tables are given in this pamphlet, one describing in detail the most intense rainstorm at each of 208 stations; the other giving the maximum rates of precipitation at each station for periods of 5, 10, 15, etc., minutes up to 12 hours, although there are comparatively few records for more than 2 hours. There are also given sixty charts showing by isohyetals the 5-minute, 10-minute, etc., rainfalls to be expected in each part of the United States once in 2, 5, 10, 25, 50 and 100 years; also others showing, for each part of the country, the number of excessive rainstorms that have occurred in each of the 12 months during the past 30 years.

The accompanying illustration shows the 10-year charts, which are those perhaps most useful in sewer designing; also two 100-year charts for comparison. (These show not hourly rates but actual rainfall during the time indicated.)

We also give herewith a table in which are shown the maximum rates of precipitation at one station in each State (in three cases a second station is given where peculiar topography caused widely differing rates). In selecting these stations, we took those which showed the highest rate, for a 20-minute period, of all stations in their respective States. We have also arranged them in order from north to south, in tiers passing from east to west, to permit easy study of effect of geographic location on rainfall rates.

*This pamphlet may be had by sending ten cents to the Superintendent of Documents, Washington, D. C., asking for "Miscellaneous Publication No. 204, Rainfall Intensity—Frequency Data."

New Uses for Explosives

Explosives technical men every now and then develop new methods of blasting, some for increasing the efficiency of explosives and effecting economies in the costs of using for mining, quarrying, construction and other industrial purposes where blasting is essential.

As lately as January of last year, in removing piles along the shore at Beach Haven, N. J., explosives men evolved a method of blasting which, in effect, gave shearing power to dynamite explosions. In doing this work, a water jet was used to make holes alongside the individual piles to receive the charges of dynamite, and cartridges attached to strips of wood were pushed down as water from the jet displaced the sand. This made possible the "shearing" off of the piles at a sufficient depth to prevent what had been a menace to bathers and others using the beach.

Of outstanding importance in road building has been the development during the past few years of methods for accelerating the sinking of highway embankments on marshy and in other unstable areas. The application of explosives to this type of work is fully recognized as an outstanding contribution to highway construction.

Making "earthquakes" to find oil is one of the most interesting and spectacular, as well as useful, purposes for which dynamite is used. By exploding charges of dynamite artificial tremors are created, and by making readings of the recordings of portable seismographs located at the proper points, the geophysicist obtains an idea of the presence and depth of significant strata. Before the seismic method was adopted, many millions of dollars were wasted in drilling, only to discover there was no oil.

Disposal of Refuse by Combined Reduction and Incineration

A NEW garbage disposal plant for disposing of the garbage of 400,000 persons in the northeastern part of Philadelphia was formally opened for operation on July 2nd. Here the garbage is being disposed of by a new process which the officials believe to be cheaper, more rapid and more sanitary than any heretofore used.

A building 166 ft. long by 80 ft. wide houses four furnace units of 280 tons capacity in 24 hours. Connected to it is another building 75 by 35 ft. containing 12 digestors, receiving tanks, hydraulic presses, storage tanks for liquid and grease, with a capacity of 96 tons of garbage in 8 hours.

The collecting wagons and trucks dump the garbage into a receiving pit in the incinerator building, from which it is carried to the digestion tanks by steel conveyors. When a tank has been filled it is sealed and the garbage cooked by steam delivered from a boiler connected to the incinerator furnaces. Gases formed during the cooking are taken off by condensers which are connected to the sewer. The cooked garbage is dropped into a receiving tank and from this into large horizontal hydraulic presses with a capacity of 2.7 tons every 45 minutes. The liquid from these is removed through a sluice to large settling tanks, from which the greases are removed and the remaining liquid is discharged into the sewer. The solids from the hydraulic presses, which are approximately 20% by weight of the original garbage, are highly combustible and are fed bv conveyors into the incinerator furnaces.

The grease is sold, and. at the present market price will bring the city, it is estimated, $16,000 a year, completely offsetting the operating cost; whereas by the former method of burning mixed garbage and refuse the cost was $2.12 a ton with no by-products.

There are no obnoxious odors during operation, and the former odors from stored garbage (waiting for delivery of combustible rubbish) are eliminated.

Formerly the garbage was burned in incinerators mixed with rubbish which it had been calculated would suffice to evaporate the 85% of water in the garbage. However, as 54% of the rubbish collected was not combustible (being tin cans, bottles, etc.) it did not furnish sufficient heat. This was aggravated by the fact that the rubbish collections were lightest over the week ends, and the garbage collections heaviest, so that garbage often remained on the incinerator floor for a day or two before enough rubbish had been collected to burn it. By squeezing out the water all this difficulty has been eliminated.

The new process was devised by George W. Kelley, general superintendent of the Bureau's reduction and incineration plants, and approved by A. M. Soby, chief of the Bureau of Street Cleaning, Frank H. Caven, Director of Public Works, and Mayor J. Hampton Moore. For the above information we are indebted to Joseph E. Gill, principal assistant engineer, Bureau of Street Cleaning.

Handling the Problem of Icy Roads

HOW they handle this problem in an endeavor to minimize danger of traffic accidents is told by officials in charge of state and county highways in the following brief statements:

Sanding a Massachusetts State highway, January, 1935

New Hampshire

Icy pavements are sanded with mechanical units which are, in general, mounted on 1½ ton trucks. The full width of the pavement is sanded at railroad crossings, on hills and curves. When conditions are particularly dangerous, a width of ten or more feet is sanded in the center of the roads on tangents. The quantity of sand used varies from one to two pounds per square yard for each trip with the sanding machine. The volume of traffic, location and condition of road surface determine the quantity to be used.

The costs for sanding during the winter of 1934-35 amounted to $137,489.31 on 1456.4 miles of state highways, or practically the same as for plowing. Calcium chloride is mixed with the sand, and during the winter of 1934-35, $12,685.53 was expended for this chemical. *—By F. E. Everett, Commissioner, Highway Department.*

Massachusetts

The cost of sanding is approximately equal to that of plowing, which amounted in the year ending November, 1934, to $343,088.13. This is due to the fact that our traffic is especially heavy and the snow becomes packed and requires sanding. Due to the climatic conditions, we have a great many days when the snow melts a small amount in the middle of the day and freezes in late afternoon, necessitating sanding for several days following a storm, sometimes one of minor proportions. Calcium chloride is mixed with the sand to prevent it from being thrown from the icy surfaces by the vehicles and to assist in melting the snow and ice. In doing the sanding, mechanical sand spreaders are used for the greater portion, and the hills and curves are sanded first. If any of the other sections are particularly dangerous, these are given attention.

For the fiscal year mentioned above 2517 tons of calcium chloride were employed in sanding work, and 74,872 cubic yards of sand were used. The state owns 134 sand spreaders, and, during the year, hired 31 others.—*By A. W. Dean, Chief Engineer, Department of Public Works.*

New York

Ice control is really a responsibility of the counties. We do, however, sand and cinder steep grades, sharp curves and places on the state highway system where numerous accidents have occurred. It has cost us as much as $500,000 to do this work in a single winter.

I am firmly convinced that snow removal and the sanding of slippery pavements should be handled together.—*By David Noonan, Assistant Commissioner of Highways.*

Indiana

During the winter of 1934-35 we had an unprecedented amount of ice, rendering the highways slippery and dangerous. To eliminate the danger from this source, we stock a mixture of cinders, sand or stone screenings, and calcium chloride. The chemical keeps the piles from freezing and when applied, sets the grit into the ice. On curves and grades, this mixture is applied by hand by patrolmen; on tangents, where fine aggregate and salt or calcium chloride are used, distribution is by hand or by mechanical spreaders.

The removal of the ice coating is started as soon as possible. One of the most effective means for this is to scrape the surface with a notched blade which will cut grooves in the ice, and crack that in between, so that it can be removed by an unnotched blade. If the temperature rises sufficiently, the ice previously treated with the salt or calcium chloride mixture is softened so that it can be removed with only the straight blade.—*By C. W. McClain, Engineer of Maintenance, State Highway Commission.*

Idaho

The sanding of the more slippery areas, particularly on grades, is the only ice control work undertaken by this department.—*By G. E. McKelvey, Commissioner, Department of Public Works.*

Oregon

Oregon makes a practice of keeping all unusually slippery highways well sanded, but chemicals are not used for the purpose. In the fiscal year of 1934, $4,552.90 was expended on the work.—*By R. H. Baldock, Engineer, State Highway Commission.*

California

Efforts toward ice prevention and removal are confined principally to sanding frosty or icy sections of pavement to insure traction for motor vehicles. Sand mixed with salt in the proportion of about 100 pounds of salt to each cubic yard is stockpiled in shelters at convenient locations prior to the winter season. During the 1933-34 season $14,780 was allotted for this purpose and about 1500 miles of road were protected throughout the season.—*By T. H. Dennis, Maintenance Engineer, Division of Highways.*

Richland County, Ohio

Slippery and icy roads have been important factors in causing accidents, and when this condition occurs, we try to place cinders or salt on all hills, at bad intersections, railroad crossing approaches, and other danger spots, as soon as possible.—*By Howard C. Sword, County Engineer.*

Equipment Used in Water Purification Handling Chemicals

MODERN progress in water purification has been largely a matter of selecting and applying chemicals. The use of the word "chemicals" for some years alarmed consumers, who for years opposed rapid sand filtration because they objected to having their drinking water "dosed with chemicals." However, this unjustified aversion to having substances put into water for the purpose of improving its quality has practically died out, and thousands of tons a year are so used.

The use made of chemicals may be classified as removal of suspended matters, removal or modification of matters in solution, removal of tastes and odors, and destruction of bacteria.

Characteristics of the Chemicals

In selecting equipment for handling, measuring and applying chemicals, it is necessary to know their characteristics. Most of them are corrosive to metals and some attack wood, concrete and other substances, and materials that they attack must not be used in contact with them. Some are hygroscopic and must be kept dry until used. Some dissolve readily, others dissolve slowly, and some do not go into complete solution but require continual agitation while applying. Some flow freely in granulated or powdered form, others cake and "arch" and are difficult to feed dry. Several of them deteriorate rapidly when exposed to air, others do not. Some are very dusty to handle.

Alum was and still is the most commonly used coagulant, although the use of iron salts has been increasing. This is generally used in the form of sulphate of alumina ("filter alum"). Ammonia alum is slowly soluble; its ammonium radicle is available for chlorine sterilization; but its cost is three times that of filter alum on the basis of coagulating effect. Sodium aluminate is most effective with water requiring an alkali with the alum, and, contrary to general impression, its cost per unit of alumina and sodium oxide is about the same as that of equivalent amounts furnished by alum and either soda ash or caustic soda.

Filter alum may be handled in bulk or in sacks, but is generally obtained in wooden barrels. It is commonly fed dry as a powder and is free-flowing. It tends to build up a hard coating on any mechanical parts moving through it. In solution it attacks iron, and solutions are carried in lead, rubber, stoneware or other acid-resisting materials. It is readily soluble in cold water.

Iron Salts—Ferrous sulphate ("copperas") is most conveniently used as "sugar sulphate," consisting of small crystals like granulated sugar. It costs about one half as much as alum for equal coagulating effect, but is effective only to the extent that it is provided with oxygen (either that dissolved in the water or furnished in applied chlorine) and high alkalinity either present in the water or provided by lime or caustic.

Ferric chloride is sold in three forms—liquid, crystal and anhydrous. The liquid is shipped in rubber-lined tank cars and must be stored at the plant in similar tanks of at least 8,000 gal. capacity, so is suitable for large plants only with equipment for handling and storing it and for these is the cheapest form. In crystal form it requires about 20 hours for dissolving at room temperature and is not suitable for water plants. The anhydrous form is that commonly used. It melts at 574° F. and can be stored indefinitely if the steel drums in which it comes are unopened. But when opened it is very deliquescent, and is extremely corrosive to steel in the presence of water and must be removed from the containers very soon. For which reason it is best obtained in small containers when used by small plants.

Ferric sulphate is not deliquescent, is not so corrosive as the chloride, and can be fed by dry feeders. It is shipped in wooden barrels and can be stored indefinitely. It is the most generally convenient form of iron salt for any but large plants. It has only recently been obtainable for practical use, but is now furnished by two firms under trade names.

The iron salts do not corrode rubber, glass, bakelite, ceramic materials, and certain resistant metals such as durichlor.

Lime is obtained as either quick lime or hydrated. The former must be slaked, which requires special equipment, but costs less. It dissolves very slowly and incompletely, and is generally fed dry. It has a tendency to arch in the hopper, especially in damp weather; but when mixed with air, the powder flows almost like a liquid.

Hydrated lime is more convenient for use by small plants, as it does not require slaking. It costs more, but as quicklime (which is generally purchased in bulk) cannot be stored indefinitely without deterioration, unless a plant uses as much as a car load in 60 days, use of hydrated lime is more economical as well as more convenient. It can be fed dry or in solution.

Lime should not be fed through lead pipes; but can be fed through black iron pipe (galvanized pipe should not be used for any chemicals), rubber hose and other materials. It forms deposits in pipes which are difficult to remove; for which reason rubber hose is convenient, the deposits being readily removable by flattening the hose and shaking out the broken pieces of the deposit.

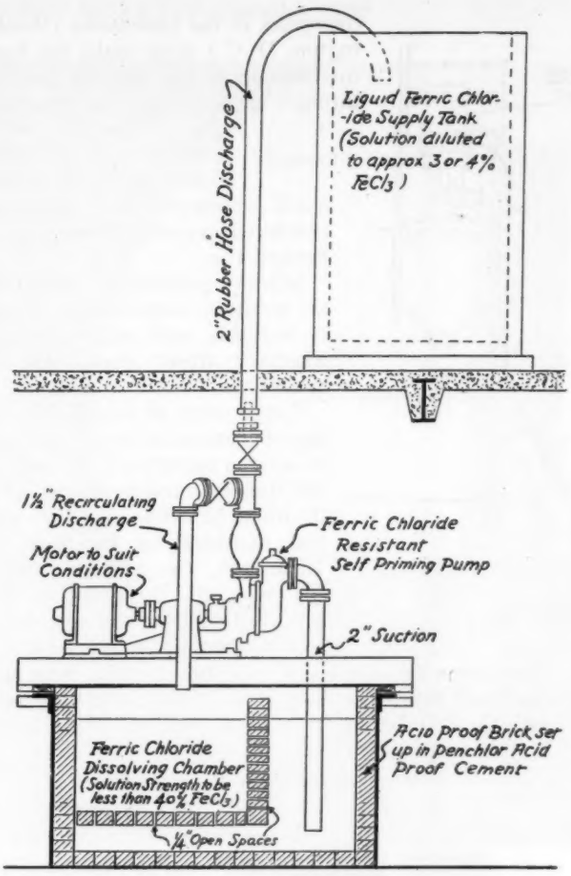
Chlorine is used either as a liquefied gas or as a solid —chloride of lime, "Perchloron" or "HTH." The gas is obtained in containers under a considerable pressure which diminishes as gas is withdrawn and is fed through special equipment. The solid forms are more stable in solution than dry, and because of this and the small amounts generally used, they are commonly measured by solution feeders. When moist they attack wood, steel, copper and many other materials, but not concrete, cast iron, lead, rubber, glass and certain acid-proof metals.

Ammonia is used either as a gas in cylinders or as ammonium sulphate. The former is obtained and applied in the same way as liquid chlorine. Its pressure increases greatly with heat, and if this exceeds 145° F. the cylinders may burst; therefore they must be stored away from steam pipes or other hot objects.

Ammonium sulphate may be fed in dry feeders, but is hygroscopic, corrosive, and readily soluble, and solution feeding is more satisfactory.

Sodium bisulphite (used for dechlorination) resembles table sugar, dissolves readily, and can be fed either dry or in solution.

Copper sulphate (blue vitriol) dissolves readily and is commonly applied to lakes and reservoirs for algae control by drawing it through the water in solid form contained in porous bags. When fed into an entering


Liquid Ferric Chloride Supply Tank (Solution diluted to approx 3 or 4% $FeCl_3$)
2" Rubber Hose Discharge
1½" Recirculating Discharge
Motor to Suit Conditions
Ferric Chloride Resistant Self Priming Pump
2" Suction
Acid Proof Brick set up in Penchlor Acid Proof Cement
Ferric Chloride Dissolving Chamber (Solution Strength to be less than 40% $FeCl_3$)
¼" Open Spaces

TYPICAL ARRANGEMENT OF ANHYDROUS FERRIC CHLORIDE MIXING AND PUMPING UNIT
Courtesy of J. M. Potter, Pennsylvania Salt Mfg. Co.

stream it is most conveniently applied by a solution feeder.

Activated carbon is generally used as a very fine powder which does not go into solution and requires violent mixing with water to "wet" it—prevent it floating to and on the surface. It is fed dry, and the feeder should contain provision for removing dust. Mixed with water it is very corrosive to iron and steel. It can be stored in moisture-proof containers without deterioration; if moistened, it increases in bulk due to adsorption of moisture but this does not decrease its efficiency. It must not be mixed with quicklime or dry hypochlorite, for then spontaneous combustion is likely to occur.

Pipe Lines for Chemicals

Most of these chemicals are received in dry form, but are mixed with water before being applied at the desired point in the plant; and all should be measured as applied, either before or after such mixing. For carrying the solutions, pipe lines should be used which are not corroded by the chemical in question.

Perhaps the best material for general use is rubber hose. It can be used for conveying either acid or alkaline solutions, is convenient for placing in the plant, is readily renewed and inexpensive. But care must be used to lay it without pockets to trap air or hold sediment. A method of jointing, and removing interior incrustation, have already been referred to.

Lead is satisfactory for alum, ammonium sulphate, chlorine gas, sulphuric acid, sodium sulphate and hyposulphite but not for lime solutions.

Black iron pipe is used for lime and soda ash.

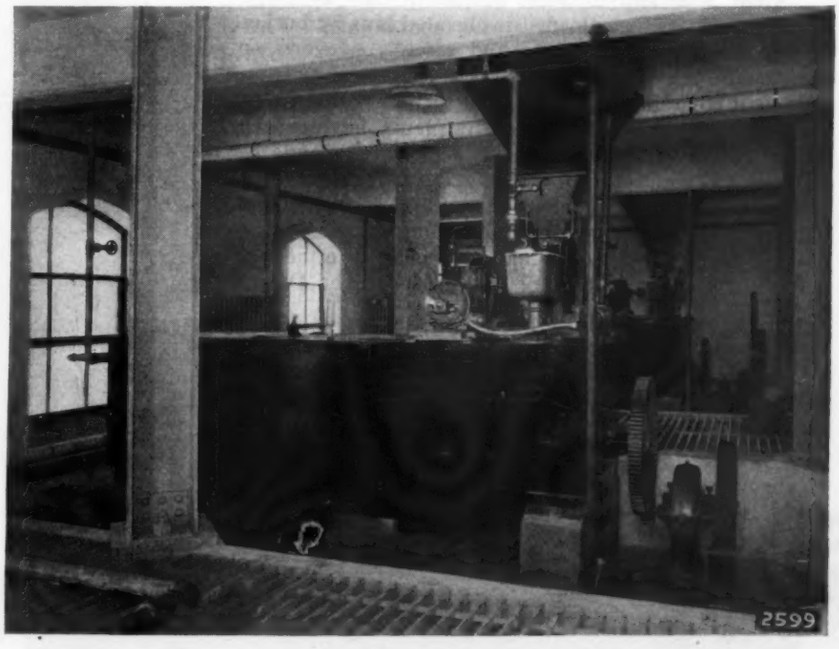
Handling Containers

Lime, ferrous sulphate or filter alum is purchased in bulk by large plants because cheaper, but for the average size and smaller plants it is much more convenient, and economical as well, to obtain them in containers of not over 400 pounds weight, which can be handled by one man on a hand truck. Even smaller sizes may be desirable when a less weight is used by the plant during the period for which they can be left open without deterioration of the chemical.

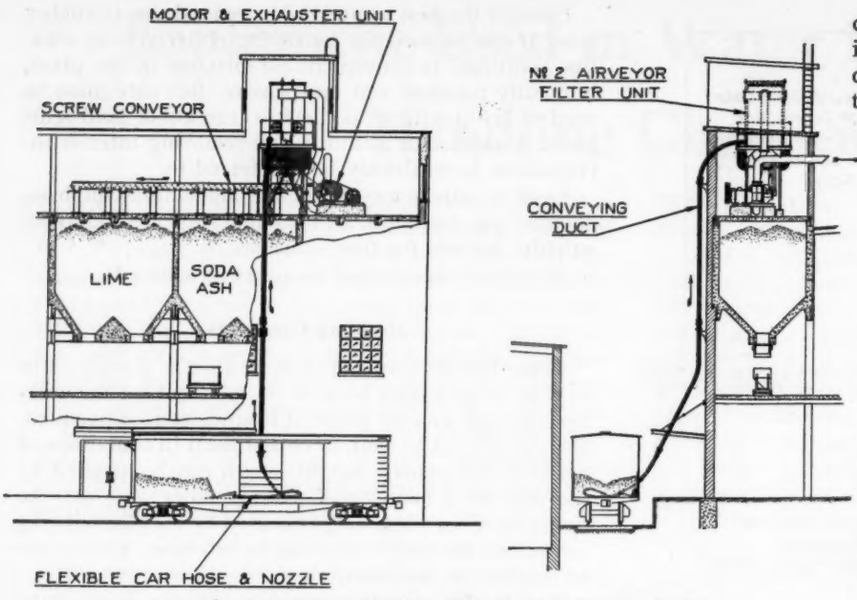
For handling such containers on the level, hand trucks are generally used, made to fit them, especially liquid chlorine and ammonia cylinders. Overhead trolleys are especially convenient. For lifting bags or barrels to an upper floor for storage, barrel elevators and bag hoists are convenient, the ordinary endless-chain bag or barrel hoist operated by a small electric motor being common. (The new Lancaster, Pa., plant uses a Stephens-Adamson bag hoist.) For a small plant, an ordinary platform elevator is generally satisfactory. A hand crane is an aid in raising barrels to discharge them into solution tanks or feeder hoppers; or a hand-operated chain hoist located over each may be used.

Moving liquid chlorine and ammonia containers on low, rubber-tired trucks is preferable to hoisting; for the latter, lifting clamps are preferable to ropes.

A platform scale should be used for checking weight of chemicals received, weighing doses applied, etc. In large plants, automatic hopper or other special scales may be useful. All of these are obtainable in any large



International lime slaker in a softening plant



Airveyor system unloading soda ash and lime—Fuller Co.

city from local firms which handle warehouse equipment.

Handling in Bulk

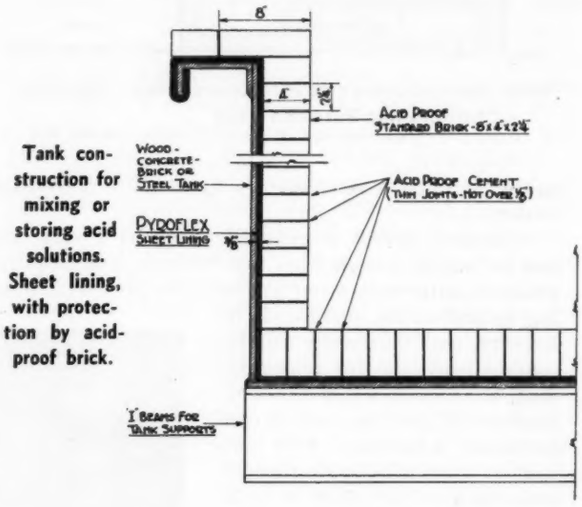
Liquid ferric chloride is withdrawn from tank cars by siphoning through rubber hose, or forcing through such hose by air pressure supplied to the tank; or, if the lift is more than 40 ft., by pumping with acid-proof pumps. Such pumps must be acid resistant, these including rubber-lined pumps (such as the centrifugal having a soft rubber lining on all exposed surfaces); or one made of acid-resisting alloy (such as the "duriron"—a high-silicon alloy). Also valves in pipe lines handling this and similar materials should be acid resistant, such as the Durichlor-Nordstrom (using duriron), the Hills-McCanna (in which pressing a rubber diaphragm between two acid-resistant metal surfaces closes the valves), etc.

Alum, lime and copperas bought in bulk by large plants is generally unloaded to elevated bins by bucket conveyors, by belt, scraper and screw conveyors, or pneumatic conveyors. Dust gives a great deal of trouble, that from lime especially, and for this reason pneumatic conveyors are used in many plants, having been furnished by the Fuller Co. ("Airveyors") and the Dracco Corporation. For dusty materials, the Airveyor delivers the chemical into a centrifugal separator and the air then passes out through a cloth filter; sucking in the material by vacuum and delivering it to the separator by either vacuum or air pressure. The Dracco conveyors in the Dalecarlia (Washington, D. C.) plant make the final distribution to the bins by gravity through chutes, while in Minneapolis a screw conveyor is used for that purpose. Some plants use pneumatic conveyors for charging powdered materials from bins to feeders also.

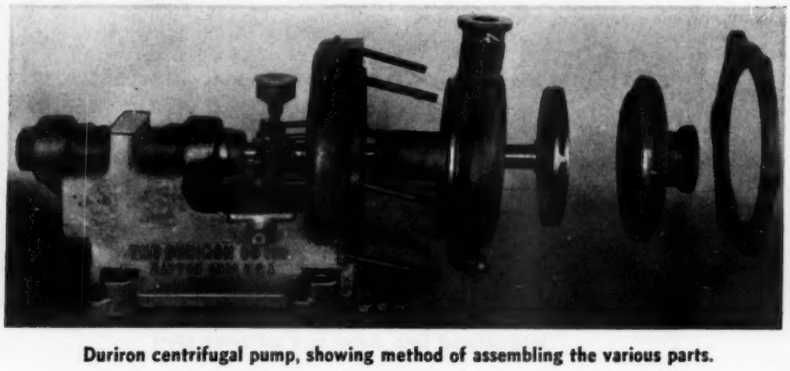
Where pneumatic conveyors are not used, a ventilating system is desirable, with intakes located wherever dusty chemicals are handled.

Large users of liquid chlorine find it economical to purchase this in one-ton cylinders 6′ 8″ long by 30″ diameter and weighing 3,300 lb. when full. These require special facilities for handling. In Richmond, Va., and the Shades Valley plant, Birmingham, they are handled from railroad siding to building by a hand-operated traveling hoist. (A beam scale for checking weight is combined with a traveling hoist by the Cleveland Tramrail Co.) Indianapolis uses a small platform-height dolly traveling on rails.

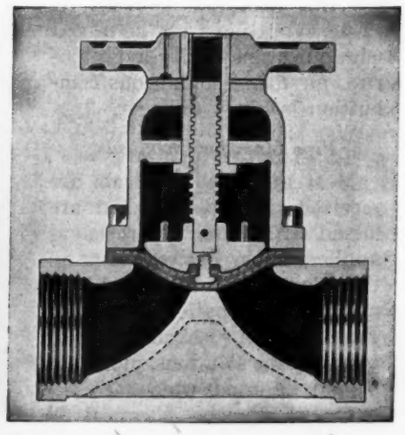
(*To be continued in the next issue*)


8'
ACID PROOF STANDARD BRICK - 8½ x 4 x 2¼
WOOD - CONCRETE - BRICK OR STEEL TANK
ACID PROOF CEMENT (THIN JOINTS - HOT OVER ⅛")
PYDOFLEX SHEET LINING
I BEAMS FOR TANK SUPPORTS

Tank construction for mixing or storing acid solutions. Sheet lining, with protection by acid-proof brick.



Duriron centrifugal pump, showing method of assembling the various parts.



Hills-McCanna Saunders type valve for acids.

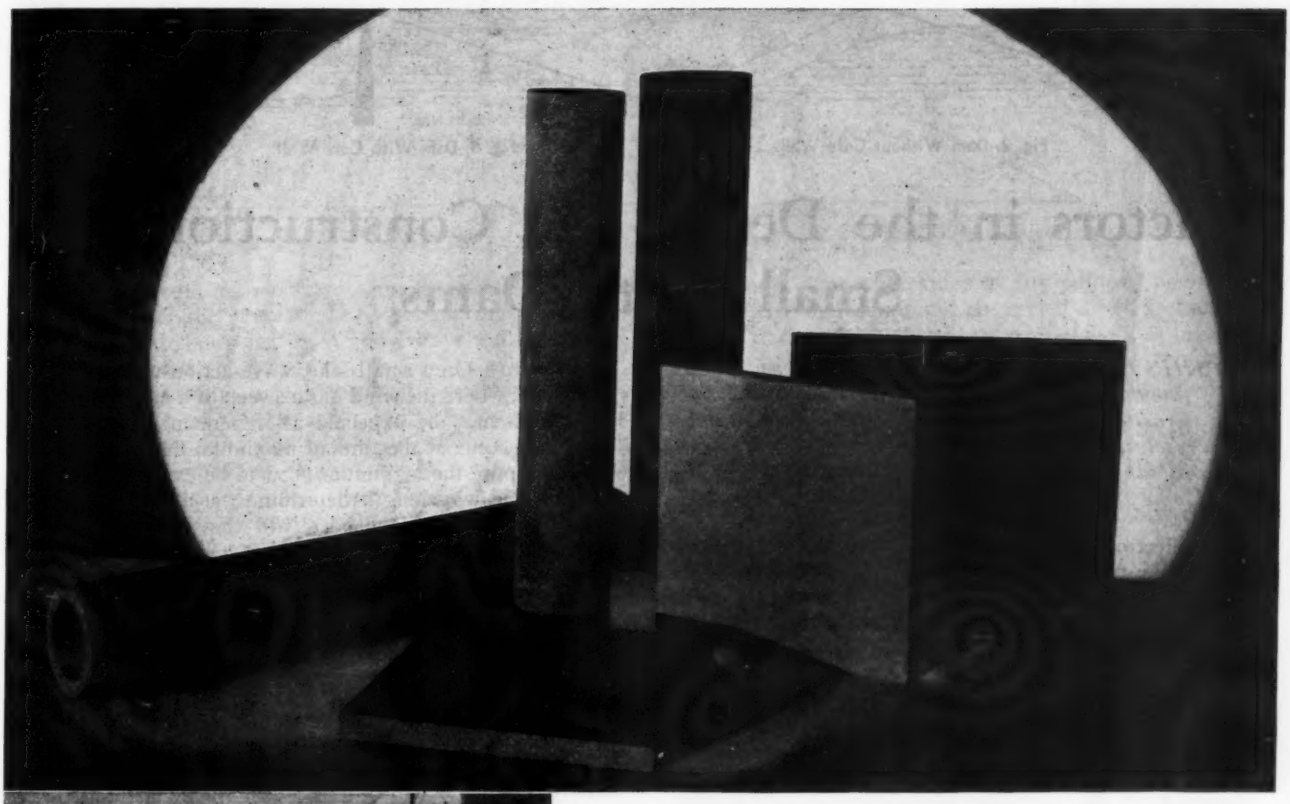


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Fig. 2. Dam Without Core Wall.

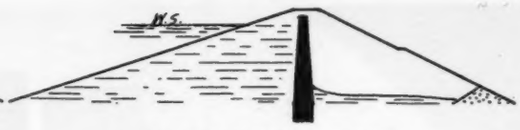

Fig. 3. Dam With Core Wall.

Factors in the Design and Construction of Small Earth Dams

THIS is the first of a series of articles which will summarize good practice in the design and construction of small earth dams. Many requests have been received from our readers for information regarding this subject, and these articles are designed to answer some of these. *W. A. Hardenbergh.*

In selecting the site for a small earth dam, there are, of course, other factors to consider than the finding of that location which will require a minimum of earth for construction. Very important are the underground conditions, since these may determine if excessive percolation will defeat the purpose for which the dam is intended, or may even cause its failure. Equally important is a safe and adequate spillway. Consider also the proximity of suitable materials and balance the cost of these in place in the dam against the volume required. A site requiring more materials which however are close at hand and capable of economical handling may prove cheaper in the end.

The Profile of the Dam—It is common practice to make up-stream slopes 2½:1 or 3:1 and down-stream slopes 2:1 or 2½:1. More depends upon the material than on any other factor, once the minimum profile for safety is reached. The line of saturation of the water passing through the dam must be kept within the downstream face to prevent sloughing or sliding of the slope. Coarse materials on this face will therefore be safe with a steeper slope than will fine materials. This question of slope is also dependent upon the importance of the dam, and on other factors which will be mentioned later. Indeed, so many of the important factors in dam design are so closely related and so mutually interdependent upon each other that it is not sufficient to consider slope entirely by itself.

On dams over 30 or 40 feet high, berms should be placed at vertical intervals of 30 feet or so. Gutters may be placed in these to carry off storm water. In addition to minimizing the erosive effect of storm water, berms add to the stability by widening the base.

Drainage of the dam itself (since even the best built earth dams pass some seepage) is accomplished by placing the coarser materials in the downstream half, by building the toe of loose stone, or by a system of drains in the dam; or in some dams by all three methods.

Freeboard—On a small lake, wave action will be insignificant; where the wind has a sweep of a mile, waves 3 feet high may be expected at infrequent intervals. These may occur at the time of maximum flow over the weir. Compute the maximum flood to be expected, and from the spillway length determine the depth of flow necessary to pass this flood. Add the allowance for wave action and a margin of safety. On dams 25 feet high, for instance, there should be at least 1 foot freeboard above any expected wave action, when the spillway is passing the maximum probable flow. Top width is important too in reducing damage from high waves.

Top Width—For earth dams generally, the top width should be approximately 20% to 25% of the height of the dam. A safe rule is 20% of the height plus 5 feet. This will care for all average cases and provides a starting point for determining unusual needs.

Shrinkage—In all consideration of freeboard and profile dimensions, make adequate allowance for shrinkage. In levee construction, material placed with a dragline will settle 20% to 25%, part of which is due to settlement of the soil under the levee. Material placed with tractors and crawler wagons, or with horses and scrapers, will settle around 15%. Earth placed in a dam in 6" or 8" layers, with properly controlled moisture content (of which more later) and compacted with a sheeps-foot or other suitable roller, will settle very little, but the earth on which it is placed may compact under the weight of the dam. A properly built dam 25 feet high on a very firm foundation should not settle more than an inch, but a carelessly built one may settle as much as 6 inches.

Core Walls—Core walls may be used, or they may be omitted. Necessity for them depends upon the type of foundation and of soil, and on the danger from burrowing animals. In actual practice, their use is more likely to depend on the preference of the engineer.

It should be noted that the use of a core wall really changes the character of the dam. A dam without a watertight curtain of this sort—the Mississippi levees, for instance—functions by offering a resistance to the flow of water between the soil particles. This friction or resistance, in the case of a perfectly built earth dam, so reduces the velocity of flow of the water through the dam that no injury results, that is, no material is car-

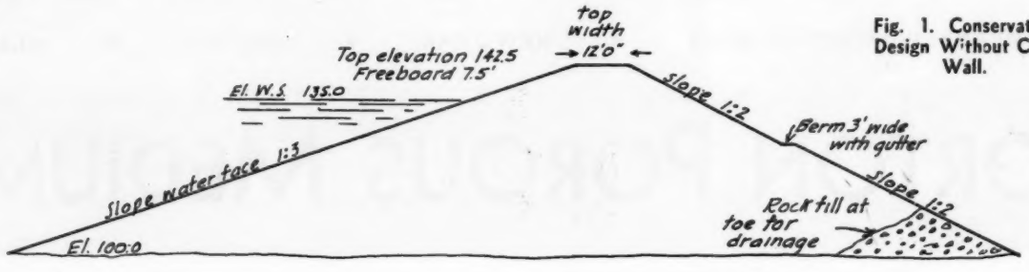

Fig. 1. Conservative Design Without Core Wall.

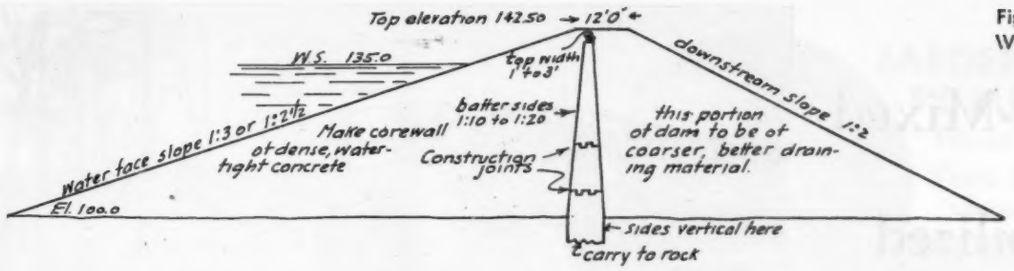
Top elevation 142.50
12'0"
W.S. 135.0
top width 1' to 3'
downstream slope 1:2
batter sides 1:10 to 1:20
this portion of dam to be of coarser, better draining material.
Water face slope 1:3 or 1:2½
Make corewall of dense, watertight concrete
Construction joints
El. 100.0
sides vertical here
carry to rock

Fig. 4. Construction With Concrete Core Wall.

ried away and no important amount of water is lost. In such a dam the surface of the percolating water will be about as shown in Fig 2, and always well within the downstream face of the dam.

In a dam with a tight corewall, as concrete, steel, masonry or wood, the earth upstream from the core wall becomes saturated with water as shown in Fig 3, and a head is built up on the corewall equal to the head of water behind the dam. Therefore, if a crack or hole develops in the corewall, the head of water above this point tends to force water through the opening. Then, if the material below the corewall is not sufficiently porous to carry away the water passing through the opening, a dangerous condition may develop.

Strictly speaking, a dam of this type is a masonry dam with earth on the downstream face providing the mass to resist the overturning movement due to the water pressure. The upstream embankment prevents overturning of the wall, due to the pressure of the downstream embankment, when the reservoir is empty.

This change in character of an earth dam is illustrated by the recent experience of an eastern city which sought to increase the height of an earth dam by placing a curtain wall of steel sheet piling, and then adding dirt to both slopes. The original dam was of rather poor material, with some boulders a foot or more in diameter. In driving the piling, these and other conditions prevented a really watertight construction; also at the base, where ledge rock was encountered, a tight connection was not possible. As a result, water pressure built up behind the piling and, passing through these openings, threatened to destroy the dam. Repairs were accomplished by thorough but rather costly grouting.

Corewalls are ordinarily made of concrete, or pudde; sometimes of steel or masonry. In any case, the wall should be tight and so constructed as to allow the fill to settle properly around it, and it should be tied carefully to impervious strata at the bottom and ends.

Practice in corewall construction varies widely. Carefully placed and properly reinforced concrete corewalls should reach to or just above high water mark; be at least one foot thick at the top; batter (not step) to a width at the bottom of 4 or 6 feet for a 25 to 30 ft. dam; and be tightly tied to the foundation.

Rolled or puddled corewalls are quite commonly used also. A trench should be dug to an impervious stratum, filled with shallow layers of dirt, carefully rolled, and then the core carried up as the dam progresses. This core should have a thickness at any point of one-third the depth to that point, and be carried 2 to 4 feet above high water mark.

Some engineers place the corewall in the center of the dam; others about one-third of the distance from the upstream to the downstream face.

When iron or steel plates are used, they should be protected with asphalt or tar and encased in concrete. The use of rust resisting metal is desirable. Masonry laid in cement mortar is permissible, especially in low dams. While we have never seen it used, we believe a wall of sand or stone mixed with tar or asphalt would provide a cheap and flexible cut off wall. Care should be given to selecting a slow curing, flexible bitumen.

Paving of the upstream slope with concrete or other tight surface can be substituted for a central corewall, but is rarely done. When so used, it takes the place of riprap or other protection against wave action, which is ordinarily required with large dams but often omitted in small ones, especially where conditions are such that wave action will be negligible.

Outlet Structures—It is usually necessary to carry one or more outlet pipes through the dam. These should be placed in trenches dug in the original soil, and carefully backfilled. It is usually better to place concrete under these pipes and backfill around and over them with concrete. Cut off collars should be placed at intervals, these extending a foot or more out from the pipe. in order to prevent the water from following along the pipe. If a concrete corewall is used, there is less need for the collars, care being taken to get a good connection with the pipe.

If the pipe is under pressure in the interior of the dam, a break in the pipe is likely to cause failure of the dam. It is therefore desirable to have the control gates at the upstream edge of the dam, and this may be accomplished by a tower at the upstream toe of the dam or by a well or tower in the upstream portion. It is often desirable to arrange so that water may be drawn from various levels, and the tower or well provides for this.

A concrete or other culvert may be built, used to carry the water from the stream during construction and later used for a pipe gallery, providing space for one or more lines of pipe.

In sizes up to 16-inch or 18-inch, gate valves are satisfactory for controls; above these sizes, iron sluice gates are cheaper and better for all practical purposes.

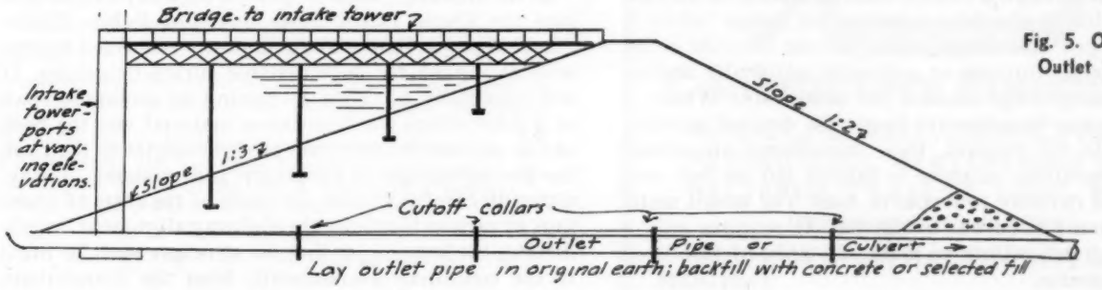
Bridge to intake tower
Intake tower ports at varying elevations.
Slope 1:3½
Slope 1:2½
Cutoff collars
Outlet Pipe or Culvert
Lay outlet pipe in original earth; backfill with concrete or selected fill

Fig. 5. One Type of Outlet Structure.

Plant-Mixed Stabilized Roads

The illustration at the right shows a stabilizer plant.

A STABILIZED road is constructed by mixing in proper proportions local materials, including clay, sand and gravel, and calcium chloride or other materials of this nature. The development of this type of road has contributed very materially to the dream of engineers of extending all-weather roads into rural sections. Inexpensive to build, such a road requires but little maintenance and offers a smooth riding surface which is free from floating materials, will not get rutted in wet weather and is dustless in dry weather. Furthermore, the stabilized surface, with its considerable sustaining power, makes an execllent base course or foundation for bituminous or other surfacing which may be applied if and when the volume of traffic requires it. Finally, the construction of such roads has offered great opportunities for the employment of labor.

Up to the present time, these roads have been constructed solely by the road-mix method. The gravel, sand and clay are dumped on the road, disced, and mixed and spread with blade graders. Calcium chloride may be mixed into the road also, or applied to the finished road. There are some objections to this road-mix method of construction, among which are the difficulties of attaining an accurate control of the volume of the various ingredients, the dependence upon proper weather conditions, and the delay often necessary for the clay to dry; in some areas obtaining water for sprinkling the surface is difficult or costly. Road-mix construction interferes somewhat with use of the road.

A plant has been developed so that plant-mixed material is now available ready for application to the road. This plant can be set up at a convenient point, as at the gravel pit, and the crushed gravel (from a separate plant) delivered directly into the pugmill mixer. The clay is fed through a control which governs the amount added, while a shredder powders the lumps before it is discharged into the pugmill. Calcium chloride is fed from a hopper through an automatic adjustable feeder, which controls the amount of admixture. Water is added as may be necessary to get the desired moisture content. In the pugmill, these ingredients are mixed, and the resulting mixture is carried out on belt conveyors for delivery to trucks or bins. The mixed material is then hauled out to the job. It requires only a spreading and rolling to make the finished stabilized wearing course.

In advance of the application of stabilizing material it is necessary, of course, to grade the road as desired; widen it if needed; and to bring the surface to the proper elevation and section so that the application of the stabilized surfacing will be a proper cross-section.

It is claimed that, due to the almost absolute control of the mixture, and a more thorough mix, plant-mix stabilization produces a better and more uniform surface, and there is less interference with traffic. From the viewpoint of construction, the spreading, drying and discing of the clay is eliminated, delays due to bad weather are greatly minimized, and less equipment is needed.

The plant illustrated herewith, which is manufactured by the Pioneer Gravel Equipment Co., is mounted on a four-wheeled, steel truck. It is highly portable and may be moved readily from one location to another. It consists of a clay feeder; a belt conveyor; clay shredder; roll crusher, if necessary; pugmill; calcium chloride hopper and feeder; and delivery conveyor.

Developments in Highway Bridge Design and Location

THE engineer who has watched the development of the motor vehicles and their increase in weight, size and speed realizes even more than ever that the bridge is an integral part of the highway, that it must conform to the highway as to width, alignment and capacity, and that it should not form an objectionable hump or make an abrupt curve to interfere with adequate sight-distance and safe driving.

River crossings used to govern highway alignment, says the Rhode Island State Board of Public Roads. The bridge was built and the highway connected thereto without regard for objectionable curves or grades. It was customary to select a crossing of minimum span at a point where the foundation material was the best, and to lay out the structure at right angles to the bank for the advantage of simplicity and economy. Today, although careful studies are made of the costs of crossings at various locations, the highway alignment largely dictates the location, so that the structure must be fitted to the conditions encountered, from the foundations,

which may or may not be the best in the locality, to the final shaping of the deck surface to conform to the profile, curve and superelevation of the highway pavement. These latter requirements usually eliminate a symmetrical treatment, and therefore add to the cost of design and construction. Aside from the additional chance of error, these complications challenge the ingenuity of the designer to devise the simplest and best proportioned layout that will fulfill all reasonable requirements of present day traffic and, so far as can be anticipated, that of the future. Fortunately this policy has governed the highway and bridge work of Rhode Island almost since the beginning of the state highway system, making the older structures that do not conform, the more outstanding.

Improvements in Material

Construction materials have been vastly improved, including the development of higher-strength alloy steels and non-corrosive steels for special uses, and the longer, deeper wide-flange beams now available make possible simple continuous-span structures.

Electric arc welding has been used very successfully in strengthening and repairing existing steel bridges and bids fair to become more popular in the fabrication of steel for new construction work. The special types of light-weight floor systems also have their place, even if at greater cost, because of the reduced deck thickness, or by adding to the live load capacity through a saving in dead weight. Advantage could be taken of the composite action in steel beams and concrete floor slabs functioning as T-beams when additional rigidity or possibly strength is required.

In concrete structures special attention is given to the quality of masonry, using more workable mixes that will yield greater durability in combination with density and strength.

Most of the important structures on the Rhode Island highway system, and to lesser extent the smaller structures, have been designed with an eye to appearance. Today the hurrying motorist may scarcely realize that he is crossing a bridge, and with the straight alignment of roads, the pleasing lines may be practically hidden from the highway proper. Yet with the development of road and streamside recreation spots and picnic grounds through the highway beautification program, the side elevation of the bridges come definitely into view, and more than justify the care that has been used in the past treatments, and that should continue in the future, architectural fitness therefore is well justified. It can be attained at very little additional expense, and simply involves forethought in the selection of type and treatment and in the proper selection and use of materials to harmonize with the surrounding landscape. These ideals cannot be obtained by standardized plans. Air photographs materially aid preliminary studies of proposed locations and assist in the determinations of type.

The "Longest Tangent" Competition

GENTLEMEN:

In reading your November issue of PUBLIC WORKS I note on page twenty-nine, column 1, the story regarding the longest tangent.

The North Dakota Highway Department submits that its tangent on Highway No. 5, west of Dunseith, 49.467 miles, is the longest tangent in the United States. The surface, however, is gravelled; but still we think it is a damn long tangent.

Very truly yours,
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R. H. BRANT,
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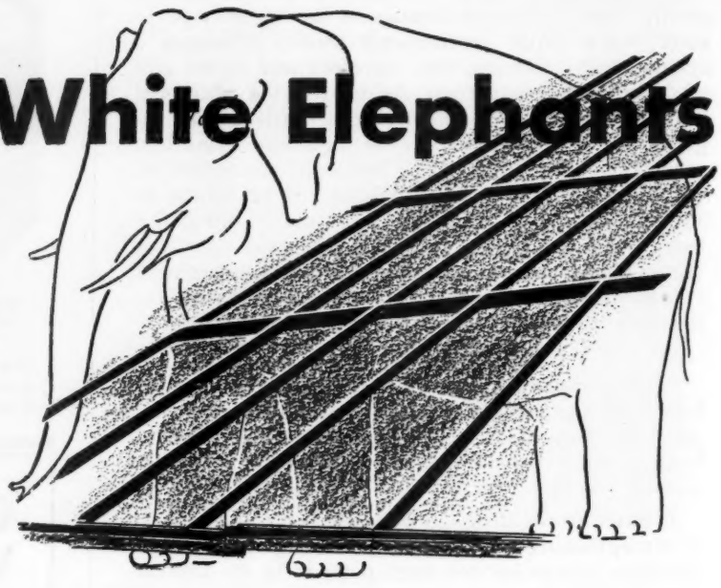
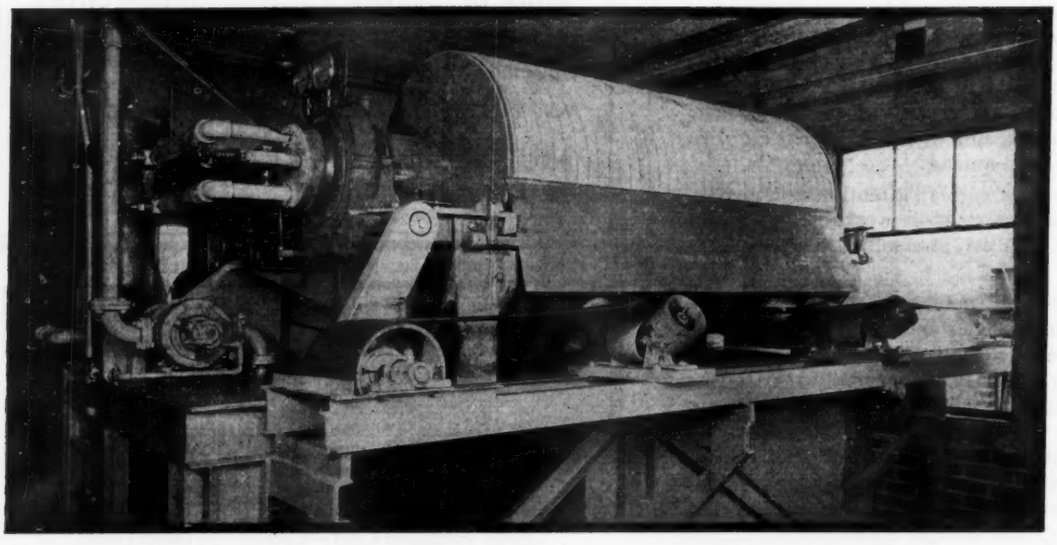


• • • *and the method of handling sewage sludge that is obsolete soon after it is installed is sure one pale pachyderm.*



Oliver Sludge Dewaterer at Long Branch, Ontario

Are you planning to install a modern sewage treating plant? If so, how are you going to dewater the sludge produced? You have a choice of two methods. One is by drying beds, open or covered; the other is by the Oliver Continuous Mechanical Sludge Dewaterer. On the matter of costs, there is little to choose between them. But there is a gap as wide as the ocean on the important matter of potential obsolescence.

The Mechanical Sludge Dewaterer is not only accepted today as a proved method of sludge dewatering, but it is steadily increasing in the preference given it by far-sighted engineers and municipal officials. It is modern today and will be modern for years to come because it is compact and easily housed. It eliminates every nuisance factor and is entirely unaffected by weather conditions. It is so flexible as to handle easily changes in sludge conditions.

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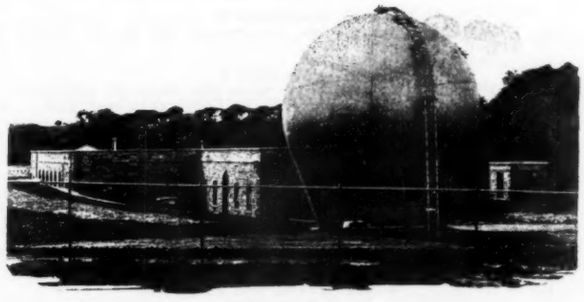
A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published.

The Digestion Tank

A **GAS HOLDER** at Beaver Dam, Wis., (population 10,000) to hold gas from the sludge digestion tank differs in form from any heretofore used, being a "Hortonsphere" with a volumetric capacity of 10,000 cu. ft., into which the gas is pumped from the floating digester cover by a compressor, which is controlled by a pressure switch which places the unit in operation when a 7-in. water pressure has developed under the cover and stops it when this pressure is reduced to 2 in. This gas holder is connected to the burners through a reduction valve which enables the operator to maintain a constant pressure on his burners. Storing of gas under pressure will tend to simplify plant operation, as it will permit gas to be used for heat or power at any time or rate desired. Part of the gas will be used for garbage incineration and heating the building, but the first call is for keeping the digestion tank at 85° F. The amount of gas produced has been as high as 17,000 cu. ft. per day. This is 1.7 cu. ft. per capita, the high rate being due to the industrial wastes, which have a population equivalent (presumably on a B.O.D. basis) of 30,000.



Welded Hortonsphere for storing digester gas at Beaver Dam, Wis.

Another interesting feature of this plant is the construction of the trickling filters, which are circular, 125 ft. in diameter. The walls were built of precast concrete members laid up as a crib wall; partly because these members could be manufactured under cover in winter by unemployed, partly to permit aeration through the openings in the wall, and partly because it cost $2,000 less than solid concrete wall.[H 11-1]

Sedimentation tanks serve not only to remove suspended solids; a very important function is the mixing of the weaker sewage with the stronger, and a capacity of 12 to 15 hrs. flow will reduce variations in the sewage to be treated and ensure a better effluent. For example, by evening the proportion of trade wastes which are discharged periodically, it secures better biological treatment of the mixture; while if the tank holds only 3 or 4 hours' flow the less diluted waste may injure the bacteria. Where strong and variable industrial sewage is to be treated, the sedimentation tank should "(1) separate settleable solids, (2) average the variations in the strength of the sewage, (3) balance the inequalities in the daily dry-weather flow, and (4) provide time for self-purification, and thus ensure that a minimum variation of load is passed on to the subsequent oxidation processes." "The only practical disadvantage of sedimentation tanks of large capacity (15 hours or more) is that the long retention of the liquid may induce septic action in the later stages of tank treatment."[D12-1]

Upward-flow tanks used for separating humus and activated sludge should be designed so as to limit the rate of upward flow to a rate less than the rate of settlement of the solids contained in the liquid. It may be as low as 6 ft. per hour for some activated sludges, or as high as 10 ft. per hour when the tanks are used for the separation of bacteria bed humus. To obtain the maximum efficiency from this type of tank, it should be designed to prevent the formation of zones of stagnant water. From the points of view of efficiency and cost there is little to choose between well-designed horizontal-flow and upward-flow humus tanks. The greater cost per cubic yard of the latter is counterbalanced by the smaller size, and the most important considerations are those imposed by the lay-out of the works and nature of the ground.[D12-2]

Garbage in sewage as a method of disposing of the former received considerable attention at the annual convention in Toronto, Canada, of the Institute on Sewage and Sanitation. It was reported that the General Electric Co. has put on the market a garbage grinding apparatus which they call the "Handy Kitchen Unit," which costs about $125; but "$125 under the kitchen sink is not yet in the picture," said one, while another was "sure that a great many are willing to pay $125 or $150 to get rid of the garbage cans." The grinder will grind chicken bones, but not heavy meat bones or peach pits, or tin cans. Durham, N. C., relieves its garbage incinerator of wet garbage (watermelon rinds, etc.) by grinding it into the sewage to be treated by activated sludge. When Indianapolis' reduction plant was stopped by an accident, all the city's garbage was ground and put into the sewage, which proved so successful that it has been continued.[M12-2]

Co-ordination of treatment plants in and around London was recommended by the Minister of Health (England), the recommendations being summed up as follows:

"(1) That all arrangements for sewage disposal in and around the Metropolis should be co-ordinated and planned with regard to an area of 25 miles radius, or thereabouts, from Charing Cross.

"(2) That for this purpose consideration should be given to a scheme whereby the whole of this area would be served by ten, or fewer, centralised disposal works.

"(3) That, within this area, all further main sewerage and sewage disposal works, or extensions of existing works, should be designed so as to conform with the foregoing.

"(4) That special measures should be taken to give effect to the above recommendations."

Of the ten purification works suggested, three are already in being—one at Heston and Isleworth, Mid-

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dlesex; one at Barking; and one at Crossness. Others are receiving consideration from members of county and town councils adjacent to the Metropolis.[D12-8]

Roots in sewers are killed by copper sulphate by several cities. It requires several days or weeks to do so, but it kills the fine roots, and the flowing sewage moves the larger ones back and forth until they break off. In some cases the sewer was so blocked by roots that the manhole above was flooded, and the copper sulphate could not be got to the roots until part of the obstruction was removed by rodding to start a flow; but if it is applied when the stoppage is still partial, a double handful of copper sulphate crystals being thrown into the manhole just above the stoppage, the roots quickly die. This will not prevent future growth of roots and must be repeated from time to time as new roots enter the sewer.[M12-2]

Bibliography of Recent Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract), *t*, technical article.

D 12 — *The Surveyor*

October 18

1. Factors in the Design of Sewage Disposal Works. By H. C. Whitehead, pp. 403-407.

October 25

2. Factors in the Design of Sewage Disposal Works. By H. C. Whitehead, pp. 433-439.
3. Sewage Treatment at Bradford, pp. 439-440.

November 1

4. Chlorination in Sewage Treatment. By R. W. Covill, p. 471.

November 8

5. *p.* Phenomena Associated with the Role of Nitrogen in Biological Oxidation. By F. R. O'Shaughnessy and C. H. Hewitt, p. 489.
6. *p.* Activated Sludge Systems and Percolating Filters in the Balance. By W. F. Snook, pp. 493-494.
7. Discussion of D12-4, pp. 497-498.
8. Developments in Sewage Disposal. By J. D. Watson, pp. 499-500.

E 12 — *Engineering News-Record*

November 7

1. *c.* Hydraulic Mining on Twin Cities Sewer Tunnels, pp. 627-631.

G 12 — *Water Works and Sewerage*

November

1. Sewage Disposal and Water Supply at Singapore. By I. W. Mendelsohn, pp. 371-374.
2. Primary Elements for Sewage and Water Works Meters. By L. D. Carlyon, pp. 375-378.

H 12 — *Municipal Sanitation*

November

1. Flexibility in a Small Treatment Plant (Kirkwood, Mo.). By S. W. Jens, pp. 326-328, 340.
2. Investigation of Pollution of Bathing Beach Waters. By H. L. Nelson, pp. 329-332.

J 12 — *American City*

November

1. Dynamite in Sewers. By A. B. Backherms, p. 46.
2. Chemical-Mechanical Treatment of Sewage (Perth Amboy, N. J.). By L. P. Booz, pp. 65, 67.

K 12 — *Proceedings, Am. Soc. of Civil Engineers*

November

1. Relation Between Rainfall and Runoff from Small Urban Areas. Discussion by W. W. Horner and F. L. Flynt, pp. 1363-1375.

M 12 — *Canadian Engineer*

October 22

1. *p.* Chlorination of Sewage, pp. 5-6.
2. *p.* Sludge Disposal, pp. 6-7, 9-13.

November 12

3. Supplementary Sewage Disposal Project for Toronto, pp. 3-9.

P 12 — *Public Works*

November

1. *p.* The Patent Situation in Sewage Treatment. By P. Hansen, pp. 13-14.
2. Nation-Wide Abatement of Water Pollution, p. 16.
3. Cost and Results of Boulder's Sewage Plant, pp. 17-18.
4. *p.* Design Features of Depressed Sewers, p. 18.
5. Chemical-Mechanical Treatment of Sewers. By P. B. Streander and M. J. Blew, pp. 22-24.

HH 12 — *Proceedings, Maryland-Delaware Water & Sewerage Ass'n.*

Year 1935

1. Design of Moores Run Interceptor Sanitary Siphon under Herring Run Valley, Baltimore, Md. By F. H. [illegible]roved, pp. 111-123.

Sewage Treatment as a Business

The engineer of the Springfield (Illinois) Sanitary District, W. B. Walraven, who by developing sewage-gas-operation of activated sludge air compressors was the first in this country to demonstrate the feasibility of the idea, at a meeting of the Kansas Water and Sewage Works Ass'n, discussed very instructively the subject of economy in operating sewage treatment plants.

The Springfield Sanitary District plant cost $600,000 to build and $30,000 a year for operation and maintenance. Add to the latter $47,000 for interest at 4½% and depreciation at 3⅓%, and $3,000 for administration, and the gross annual cost is $90,000. With a reduction of suspended solids and oxygen demand of 90% (they obtained 92% for the year 1934), this gives a cost of $1,000 per annum for each 1% reduction. If a less efficient superintendent were employed at $1,000 less a year salary, and he secured only 80% reduction, the resultant purification would be worth relatively only $80,000 but would cost $89,000.

The same argument holds for equipment also, and up as well as down. In 1932 Mr. Walraven installed a 180 h.p. gas engine to operate the blower which furnished air to the activated sludge plant. In 1934 this engine compressed 1787 million cubic feet of air; which service, if performed by electric motors, would have required 934,300 kwh. which would have cost $9,343. The gas engine, gas holder and changes in plant for using same cost $15,728. After accounting for interest, repairs and maintenance, the net savings during two years of operation have more than paid for the entire investment, and the trustees approved the purchase of a second 150 hp. engine to use the rest of the gas, driving a small air blower and an electric generator.

Among some of the minor economies practiced at Springfield was the use of clarified plant effluent for sprinkling the extensive lawns around the plant, for which considerable money had been spent each year for water. This was distributed by a centrifugal pump through a few mains which were laid for the purpose, and the effluent used abundantly in dry weather.

Another was keeping the aeration plates clean. Mr. Walraven knew of plants where the pressure had been rising steadily for years, with resulting increase in cost of air compression, because no attention had been given to the clogging of the plates. In one plant the pressure of 7.5 pounds per square inch originally required rose in a few years to 9.0 pounds. Either the old plates should be cleaned or new ones replace them. The latter would cost $1,800, but the saving in power would be more than that in one year.

The cost of sand for the sludge drying beds is quite an item. In 18 months, most of the sand had been removed from the Springfield beds during successive removals of dried sludge; and replacing it on four of the twelve beds cost $200. It was noticed that the grit removed from the grit basins "consisted largely of small cinders, coal, sand, bits of glass and other like material. Knowing that this drains and dries readily, we wondered whether it might not be used instead of sand upon the drying beds. We tried it on one bed and discovered that the sludge drained as well on the grit as on the sand. Consequently we adopted the policy of saving all the useable grit taken from the basins, and are probably safe in saying that during the past four years our expenses have been reduced by at least $350 per annum. It is true that the grit is sometimes unfit for such use, but in general the bulk of all obtained is carefully stored away for use on the drying beds."

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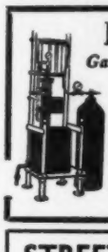

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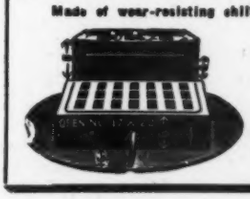

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Following is a digest of the important articles published last month having to do with water works design, construction and operation and water purification, arranged in easy reference form.

The Water Wheel

MEASURING water by differential pressures is effected by use of venturi tubes, flow nozzles, and orifices. In selecting the type for a given project, consideration should be given to initial cost, installation, accuracy, reliability, pressure loss, and future capacity change. Large venturi tubes increase rapidly in cost as size increases, and all sizes cost more than do the other two. On the other hand, the pressure loss is much less—generally a third to a fourth as great—and the saving in pumping resulting might easily more than offset the first cost. The venturi is more difficult to install, especially in an existing line; but requires 5 to 10 pipe diameters of straight line preceding the location, while the others require 8 to 20 diameters. Each claims an accuracy of at least 99%. As to reliability, all should function with satisfaction indefinitely with practically no attention.[G12-2]

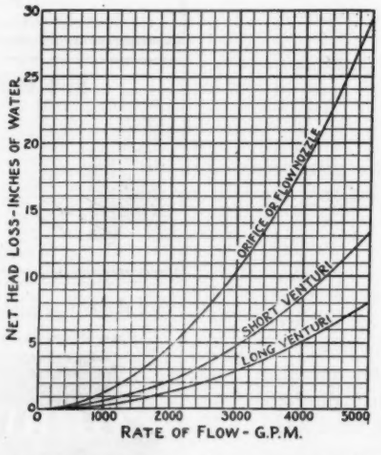
Cast iron pipe joints were tested for pull-out strength at Ohio State University Experiment Station in sizes of 6" to 20", pressure being exerted by closing the ends of a line of pipes and exerting water pressure therein; from which they developed the formula $P = \frac{3800}{D+6} - 40$, in which D is the diameter of the pipe in inches and P is the water pressure in pounds per square inch. This applies to calked lead joints and also to sulphur compounds. Lead showed a distinct flow under the loads, indicating that a joint will sustain for a brief time a much larger load than it will carry for a long period. In nearly every test, failure began by the spigot slipping through the lead. A long-time experiment with a sulphur compound joint indicated that the strength of the material improves greatly with age, and one joint re-waterproofed itself after it had been broken.[E11-1]

Cast iron pipe specifications, according to Committee A — 21 of the A.S.T.M., should not contain requirements for process and metallurgical control, unless possibly a limitation of 0.10% for sulphur and 0.90 for phosphorous. From laboratory tests at M.I.T. it concludes that no practicable variations in iron mixtures will materially change or reduce susceptibility to corrosion. Addition of silicon which would do this would be prohibitive in expense and produce an iron brittle and impracticable to cut or tap.

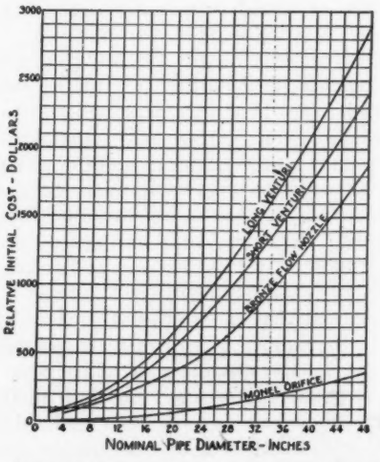
Tests of loss of head in tees, crosses and bends of 6" to 12" diameter, and studies of losses in distribution systems, led to the conclusion that short fittings give no more total loss of head in distribution systems than do long fittings, although in pumping stations where velocities are high long-radius fittings are desirable. [A12-17]

Licensing operators of water purification plants is required by state laws of New Jersey, Michigan and West Virginia; while Ohio effects the same by means of the Registration Law for Professional Engineers, and the Texas Water Works Ass'n has established a voluntary system of licensing. West Virginia makes use of a law which permits the Public Health Council of the State to issue regulations pertaining to the operation of filter plants. The committee did not have a single reply from a licensed operator who did not favor such regulations. It suggests that, for a city where sedimentation, coagulation and filtration are used, the operator should be a graduate of a recognized college with a degree in sanitary or chemical engineering or public health with one year's experience; or in civil engineering or a B.S. with chemistry major, with 2 years' experience; or a B.A. with courses in water chemistry with 3 years' experience; or two years in college with 5 years' experience; or, if with no college education, with 5 to 10 years' experience.[A12-16]

Ozone treatment in Hobart, Ind., removes high vegetable taste and odor completely and reduces the color to from 0 to 2, and reduces to 0 the B Coli count of 8 in the filtered water. The equipment comprises a 25 k.v.a. transformer (208—18,720), 10 h.p. electric pump, ozone generator, combined circulating tank and aerator, dehydrating refrigerator and air cabinet. One k.w.h. is used per 1,000 gal. of water ozonated. Based on 60,000,000 gal. per year, the cost, additional to that for current, is 5 cents per 1,000 gal. for interest and depreciation (10%), and 1 cent for maintenance. The ozonators were installed in the existing filter building early in 1932.[J12-2]



Net differential head loss created by the different types; 53" of water maximum differential; 5,000 g.p.m. in 20" main.



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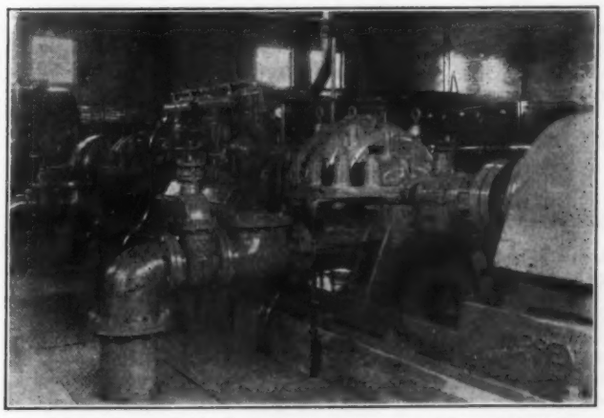

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Maximum raw water pollution safely permissible to permit adequate purification, producing effluents meeting both requirements of the present Treasury Dept. B Coli standard, are believed by Streeter to be: For waters requiring filtration—The average B Coli index of the raw water as delivered for treatment, when considered over a significantly long period of time, such as a year, should in no case exceed 5,000 per 100 cc.; and should not exceed 20,000 per 100 cc. during more than 5% of the period considered, in which case the limiting B Coli index might be as high as, or something less than 5,000 per 100 cc. according to the character of the source and the variability of the water taken from that source. For waters requiring only chlorination—The average index of the raw water, when considered over a similarly long period of time, should not exceed 50 per 100 cc., or a figure sufficiently lower so that the number would not exceed 400 per 100 cc. for more than 5% of the time.[A11-2]

Diesel engine by-products not often used are the hot water, exhaust heat, and the CO_2 in the exhaust gases. The hot water can be used for lime slaking in a softening plant, in the laboratory, washroom and shower bath. A considerable amount of heat, up to about 35% of the B.t.u. in the fuel, is present in the exhaust gases, much of which could be recovered for heating the building.

The CO_2 is used in Midland, Mich., for stabilizing water softened by the lime process, bringing the pH from 10.2 to 8.2. Prior to 1934 this had been done by CO_2 obtained by burning coke at a cost of $30 a month. Since then the exhaust of a 200 hp. Worthington diesel engine (which operates a generator) has furnished sufficient CO_2 to stabilize 3 mgd. The exhaust was found to be of uniformly satisfactory quality, with low sulphur content and so free from objectionable constituents as not to need scrubbing.

Fifty percent of the exhaust heat was recovered, and heated the building all last winter, effecting a saving of $250. The use of the CO_2 effected a saving of $304.[F11-3]

Bibliography of Recent Water Works Literature

To find an indicated reference, find the given letter and bold-face number at the left of the column, and the light-face number (following the dash) immediately below this. The bold-face number indicates the month of issue of Public Works in which the article was listed, which is generally the current but may be a previous one.

c, Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract), *t*, technical article.

A 12 — *Journal, American Water Works Association* — *October*

1. A Suggested Water Works Collection Procedure. By M. F. Hoffman, pp. 1273-1277.
2. Financial History and Present Financial Policy of Cincinnati Water Dept. By A. S. Hibbs, pp. 1278-1283.
3. Sales Taxes in Relation to Water Utilities. By D. L. Maffitt, pp. 1284-1289.

4. Recording Physical Property Data. By C. Haydock, pp. 1290-
5. Collection of National Water Works Data. By N. B. Jacobs and J. W. Guilday, pp. 1297-1306.
6. Relation of Engineering and Accounting to the Item of Depreciation for Rate Making and for Taxes. By E. E. Bankson, pp. 1307-1322.
7. Should Municipal Plants Be Regulated by Utility Commissions and Be Subject to Taxation? By J. A. Beck, pp. 1323-1330.
8. Accounting Uniformity. By H. Boggs, pp. 1331-1342.
9. Review of the Special Lien Bond Situation. By R. A. Taft, pp. 1343-1356.
10. Preventing the Theft of Water. By C. M. McCord, pp. 1357-1359.
11. Stub Billing. By T. G. Banks, pp. 1360-1362.
12. Storage Yard and Material Handling. By W. V. Weir, pp. 1363-1365.
13. Painting, Markings and Other Characteristics of Fire Hydrants. By T. L. Amiss, pp. 1366-1371.
14. Is a Record System of Underground Water Mains Justifiable? By E. A. Munyan, pp. 1372-1385.
15. Progress in Dams and Pipe Lines. By T. H. Wiggin, pp. 1386-1391.
16. Licensing of Water Works Employees. Report of Committee, pp. 1392-1405.
17. Specifications for Cast Iron Pipe. Report of Committee, pp. 1406-1409.

D *The Surveyor*

12 *October 18*

1. *c.* Reservoir Construction (at Dudley, England), pp. 411-413.

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2. London's Water, pp. 469-470.
3. *n.* Wood Joints in 90-Year-Old Water Pipe, p. 472.

E *Engineering News-Record*

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1. Recent Taste and Odor Tests of Paints for Water Tanks. B. G. L. Hall, p. 639.

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2. Rainfall in Muskingum Valley Unusually Heavy in August Storm, p. 689.

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2. $1,000,000 Water Softening Plant (Hamilton, O.). By R. W. Wolfenden, pp. 1238-1239.

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3. New Device for Locating Hidden Pipes. By S. C. Hoare, pp. 1298-1300.

G *Water Works and Sewerage*

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1. Water Supply and Sewage Disposal at Singapore. By I. W. Mendelsohn, pp. 371-374.
2. Primary Elements for Sewage and Water Meters. By L. D. Carlyon, pp. 375-378.
3. Forgotten Meters. By E. A. Smith, pp. 387-389.
4. Experiences in Water Main Cleaning at Evansville. By C. Streithof, pp. 394-395.
5. Handling Emergency Main Repairs. By H. E. Nunn, pp. 396-397.
6. Improved Standards for Residual Chlorine Tests. By R. D. Scott, pp. 399-400.

J *American City*

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1. Water Mains Cleaned Before Softening Water. By J. A. Fulkman, pp. 45-46.
2. Ozone Solves Color, Odor and Taste Problem in Hobart Plant. By T. O. Ferkinhoff, pp. 47-48.

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1. Madisonville, Ky., New Filter Plant. By H. Arnold, pp. 11-12.
2. Run-Off Records from Dept. of Agriculture Projects, p. 21.
3. Permanent Chlorine Standards. By F. E. Daniels, p. 26.
4. *n.* Sanitary Survey of Reservoir Watersheds, p. 26.

Farm to Market Surveys in Georgia

By Henry E. Newton, State Highway Engineer

In planning the improvement of farm-to-market roads, we have a locating engineer go over the road with a survey party and run out a traverse of the old road. This is plotted up and the essential developments, such as houses, schools, churches, intersecting roads, etc., are shown on the traverse. This is then checked in the field and a decision is made as to how far it is practicable to leave the old road, bearing in mind the developments shown on the plan, in order to correct the alingment and grades.

This question having been decided, a complete survey is made, including cross-sections, drainage areas, etc., and the regular plans are prepared as is usual practice for all highway work.

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American Road Builders' Association The Road Show

On January 20 to 24, 1936, the Road Show will be held in the Municipal Auditorium at Cleveland, Ohio. Applications for space for the show have far exceeded expectations, and it has become necessary to obtain additional space in the adjacent Arcade and North Hall. The attendance is expected to be reminiscent of old times.

There has been no real Road Show since 1933, hotel exhibits having been shown in 1934 and 1935. The interest in the 1936 show is an evidence of the better status in the road building industry, which suffered severely during the past four years.

The continuance of an adequate highway program, federal aid for the construction of roads and streets, sane and adequate highway legislation, highway safety and economically sound principles in highway construction are to be stressed. The diversion of highway revenues will be combatted vigorously. Farm to market roads will receive their share of attention.

Official nominees for officers and for directors are:

For President: Willard T. Chevalier, Vice-President, McGraw-Hill Publishing Co., New York, N. Y.

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For Treasurer: James H. MacDonald, Consulting Road and Paving Expert, New Haven, Conn.

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National Paving Brick Association

The thirteenth annual meeting of the National Paving Brick Association will be held at Columbus, Ohio, January 29 to 31, 1936, at the Deshler-Wallick Hotel. Most of the sessions will be open to the general public and those interested in street and highway development are cordially invited to attend.

In addition to the business sessions of the Association, the program will consist of papers and discussions by prominent engineer and contractor users of paving brick. Recent important developments in paving brick production and utilization, including descriptions of modern brick street and highway paving and resurfacing projects, will be included. There will be a progress report of the technical study of de-aired paving brick which is being conducted cooperatively by the U. S. Bureau of Public Roads and the National Paving Brick Association. The Research Bureau maintained by the National Paving Brick Association at the Ohio State University Experiment Station will present a resume of its work and an inspection trip will be scheduled to the experimental road recently completed in Hocking County on Ohio Route 31 near Columbus. On this State and Federal Project eighteen different kinds of fillers, developed in the laboratory of the Research Bureau, have been installed.

The relationship of brick pavement construction and relaying to unemployment relief and the increasing utilization of brick for resurfacing and reclaiming old pavements and bases will be a prominent feature of the program.

O. W. Renkert, Metropolitan Paving Brick Company, is President and George F. Schlesinger, former Director of Highways and Public Works of Ohio, is Chief Engineer and Secretary of the National Paving Brick Association.

Personal News of Engineers

Francis J. Colgan and Russell Van Sauers, formerly of the city engineer's office, Port Jervis, N. Y., have been given appointments with the U. S. Engineer Department and assigned to the Wallkill River improvement work.

D. Grant Mickle, head of the traffic department of Jensen, Bowen and Farrell, consulting engineers of Ann Arbor, Mich., has been retained by the Michigan State Highway Department to direct a statewide survey of traffic volume, truck weight and sizes and general road use on the state and county highway system. This is a cooperative project between the Detroit Police Department and the Michigan State Highway Department.

F. W. Liddle, city engineer of Wyandotte, Mich., has been directed by the city council to prepare plans and specifications for a sewage treatment plant.

Donald C. Black has been appointed Engineer of Chelan County, Washington, succeeding Walter Bowen.

The executive offices of the Link-Belt Co., for many years located at 910 So. Michigan Ave., Chicago, Ill., have been moved to the Bell Bldg., 307 No. Michigan Ave.

Unit Costs, Low 10 of 17 Bidders, Shenandoah—Great Smoky Mt. Highway

7.764 Mi. Crushed Stone Surfacing, 21 Feet Wide
Bids Received Oct. 24, 1935

Item	*Unit*	*Quantity*	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
Clearing and grubbing	Acre	42	150.00	150.00	225.00	200.00	100.00	200.00	210.00	175.00	150.00	355.00
Unclassified excavation	Cu. Yd.	470,000	.45	.47	.40	.49	.42	.53	.48	.56	.75	.70
Unclassified excavation for structures	Cu. Yd.	9,400	1.00	1.00	2.00	1.25	1.00	1.25	1.00	1.30	1.25	1.00
Unclassified excavation for borrow	Cu. Yd.	10,000	.45	.30	.40	.30	.40	.35	.48	.32	.60	.60
Overhaul (station-yards)	Sta. Yd.	111,500	.02	.02	.02	.02	.03	.015	.02	.01	.015	.015
Overhaul (cubic-yard-miles)	Cu. Yd. Mi.	3,000	.15	.20	.20	.20	.20	.30	.35	.12	.15	.15
Crushed stone surfacing	Ton	27,000	1.95	1.75	1.75	1.40	2.00	1.75	2.35	1.85	2.00	2.00
Class A concrete	Cu. Yd.	1,300	23.50	22.00	27.00	26.00	30.00	24.00	24.00	21.00	21.00	22.50
Class D concrete	Cu. Yd.	350	23.50	23.00	25.00	26.00	33.00	24.00	26.00	23.00	21.00	24.00
Reinforcing steel	Lb.	141,000	.05	.04	.06	.04	.06	.05	.06	.05	.05	.045
Class A cement stone masonry	Cu. Yd.	600	16.00	15.00	15.00	16.00	18.00	12.50	15.00	15.00	15.00	18.00
Class B cement stone masonry	Cu. Yd.	800	11.00	14.00	15.00	14.00	15.00	12.50	12.00	11.00	15.00	15.00
Dry rubble masonry	Cu. Yd.	150	10.00	9.00	11.00	8.00	8.00	7.50	9.00	10.00	10.00	9.00
Grouted rubble gutter	Sq. Yd.	1,100	1.50	1.00	2.00	1.00	3.00	1.50	1.50	1.00	1.50	2.00
18″ cast iron culvert pipe—2000D	Lin. Ft.	2,500	2.30	2.50	2.50	2.50	3.00	2.50	3.00	3.00	2.25	2.25
18″ reinforced concrete pipe—2000D	Lin. Ft.	2,500	1.80	2.15	2.25	2.00	4.00	2.00	3.00	2.00	2.00	2.25
24″ cast iron culvert pipe—2000D	Lin. Ft.	54	3.50	4.00	4.50	4.50	5.00	6.00	5.00	6.00	4.00	3.75
24″ reinforced concrete pipe—2000D	Lin. Ft.	54	2.50	3.75	4.00	4.00	6.00	5.00	5.50	5.00	3.50	3.75
Hand-laid riprap	Cu. Yd.	500	4.00	3.00	2.50	3.00	3.00	2.00	5.00	3.00	2.00	2.50
Hand-laid rock embankment	Cu. Yd.	6,500	1.50	2.00	3.00	3.00	3.00	1.50	3.00	1.50	1.00	3.50
Broken stone for tree root protection	Cu. Yd.	200	2.00	3.00	2.00	2.00	3.00	2.50	1.00	3.00	3.00	3.00
6″ vitrified tile underdrain	Lin. Ft.	200	1.00	1.00	.80	1.00	1.00	1.00	.90	1.00	.75	.75
10″ vitrified tile underdrain	Lin. Ft.	1,000	1.50	1.25	1.00	1.25	1.25	1.00	1.00	1.00	1.00	1.00
18″ drop inlets	Each	34	45.00	35.00	50.00	30.00	60.00	40.00	50.00	40.00	35.00	40.00
24″ drop inlets	Each	1	55.00	45.00	50.00	50.00	80.00	75.00	75.00	50.00	50.00	60.00
Stripping and storing topsoil	Cu. Yd.	19,000	.30	.30	.75	.40	.40	.30	.30	.40	.30	.50
Placing topsoil	Cu. Yd.	19,000	.30	.30	.50	.30	.60	.15	.30	.40	.30	.30

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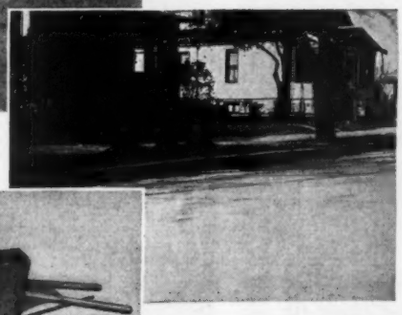
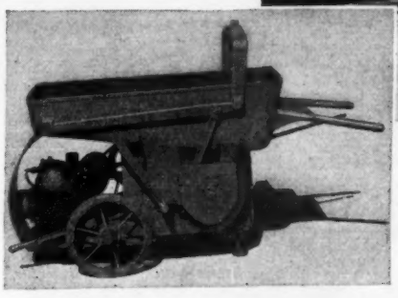
Curb and gutter depression before application of Mud-Jack Method



No. 10 N. E. C. Mud-Jack



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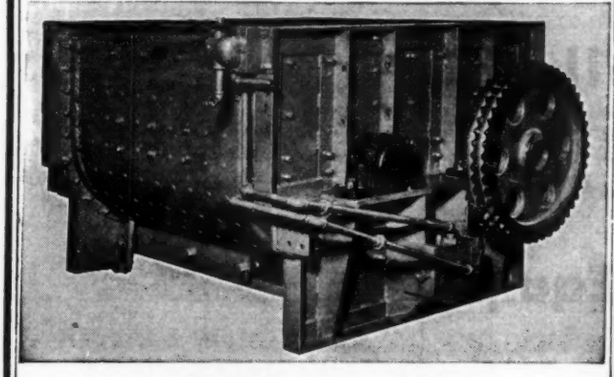

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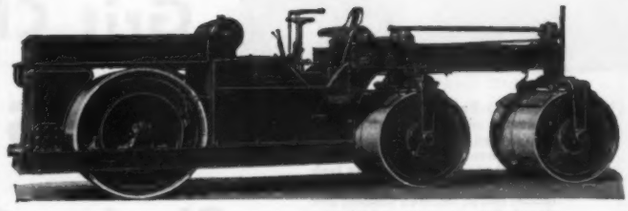

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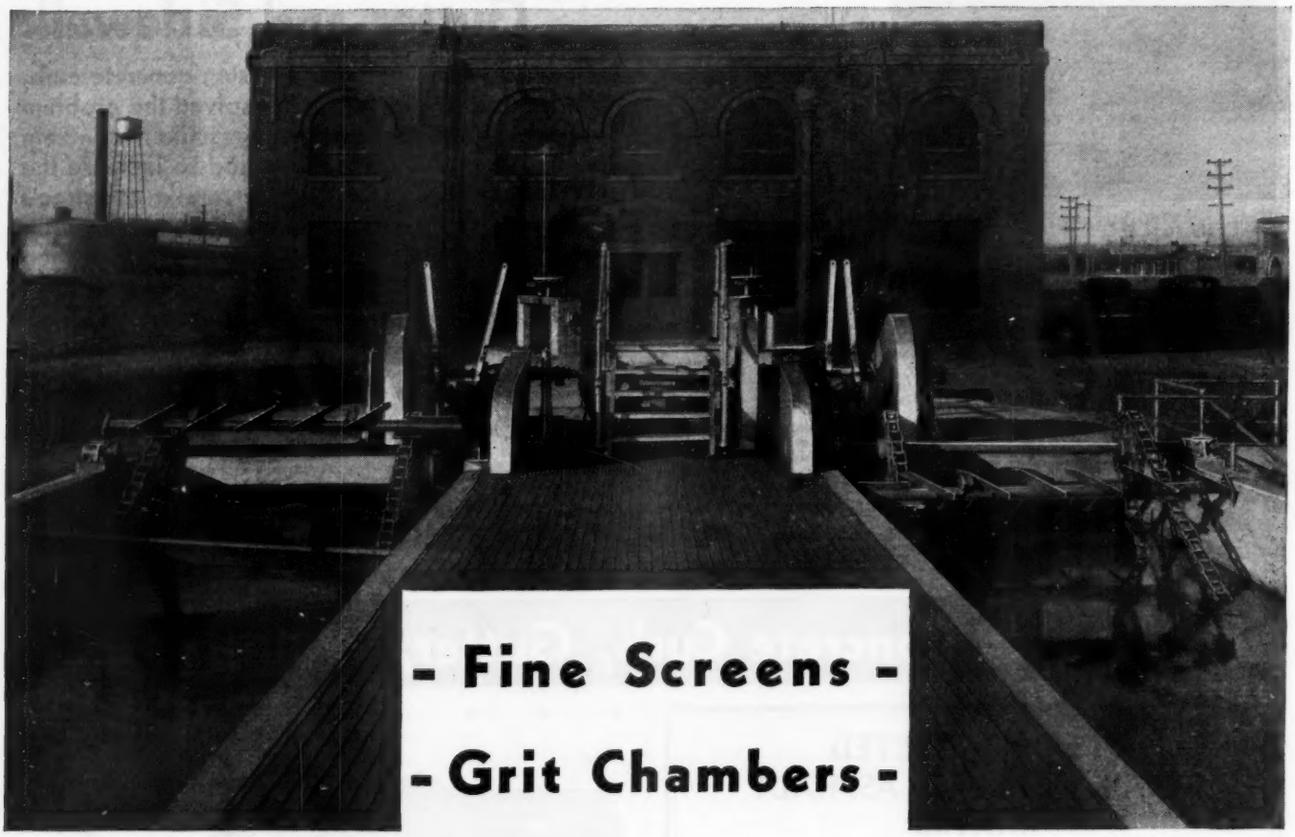

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"Caterpillar" Announces New Models:

Caterpillar Tractor Co. of Peoria, Illinois, announces four new Diesel tractors, to be known as the RD-8, RD-7, RD-6 and RD-4, and a spark ignition machine called the Thirty. These have belt horsepowers of 110, 70, 51, 41 and 41, respectively.

The first three Diesel models succeed the Diesel Seventy-Five, Diesel Fifty and Diesel Forty and are comparable with them in everything except power. Engines in these three have increased power through an increase in cylinder bore from 5¼ to 5¾ inches and other refinements that have been made in the engines and fuel injection system.

The new RD-4 and Thirty are companions in outer dimensions, chassis, transmission and tracks. Many engine parts are also interchangeable. The new machines have higher ground clearance (11⅝") and less overall height (5' ⅝") than the old Thirty tractor. The Diesel weighs only 400 pounds more than the new Thirty and almost 300 pounds less than the old, a major achievement in Diesel tractor design.

The RD-4 consumes only 1¼ gallons of low cost fuel oil an hour. The RD-4 and new Thirty have five speeds forward, fifth being 5.4 m.p.h. Drawbar pull for both (the Thirty burning gasoline) is as follows: First, 7,725 pounds; second, 5,475 pounds; third, 4,170 pounds; fourth, 3,195 pounds; fifth, 1,880 pounds; and reverse, 6,800 pounds. Speeds are 1.7, 2.4, 3.0, 3.7, 5.4 and 1.9 (reverse) m.p.h., respectively. Standard tread is 44" and for wide gauge models, 60".

Equitable Surface Heater:

The improved Equitable surface heater is designed and used for the economical resurfacing of asphalt, brick, cobble and concrete pavements and can be successfully used wherever asphalt and bituminous materials are used for repairing. Old worn out pavements are restored to their original efficiency at a saving of 35 to 45 per cent.

The heater unit is mounted on a two ton heavy duty Diamond T Truck chassis built for power at low speed. The overall length of the entire machine is 27 ft., width 8 ft. and height 7 ft.

The surface heating is 8' x 8' square and is made of heavy steel plate with skids, connecting rods and lifting cable. This hood is attached to the rear of the machine and is so arranged that when in operation will slide forward or backward on the street surface without the necessity of raising. Raising this hood is necessary only when the machine is to be turned around or when traveling from one location to another.

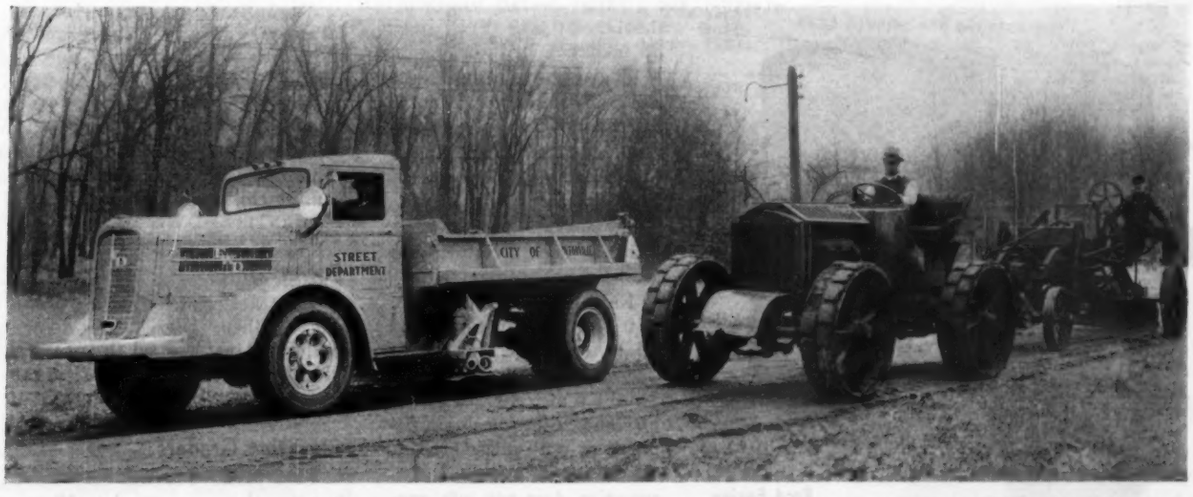
A heavy duty hydraulic hoist is used to raise and lower the hood, thus eliminating the usual manual lifting and lowering which consumes time and slows up the crew.

All operating parts are completely enclosed in the machine frame with easily operated sliding doors on both sides which can be locked. The machine is equipped with a Garden City blower operated with a 12 H.P. Nova engine. All operating parts, consisting of air blower, hydraulic hoist and pumps are provided with friction clutches, with valves conveniently located for the operator, which insures perfect control at all times.

The heater is equipped with a specially designed oil burner for heating asphalt and drawing out all moisture from brick, cobble and concrete pavements. The even intense heat makes possible the bonding of the original pavement and the new material into a solid unit vulcanizing the resurfacing material into the old pavement. Write the Equitable Asphalt Maintenance Co., Kansas City, Mo., for full details.

To Cut Pumping Costs

A new 6-inch pump has been announced by Ralph B. Carter Co., 53 Park Place, N. Y. The Ford V-8 engine has been converted for use as a power unit, providing a capacity of 96,000 gallons per hour. A new folder describes this pump, giving much information of value for engineers and contractors, including a capacity curve. Sent on request to the manufacturers or to the editor of PUBLIC WORKS.



Lewis Allen, superintendent of streets, Clintonville, Wisconsin, says that the addition of the streamlined FWD Maintainer unit pictured above has speeded up the maintenance of the city's streets by 300 percent. The former equipment, shown at the right of the picture, can now be kept in reserve for auxiliary and emergency use.

New Equipment and New Ideas

Build Your Own Motor-Compressor

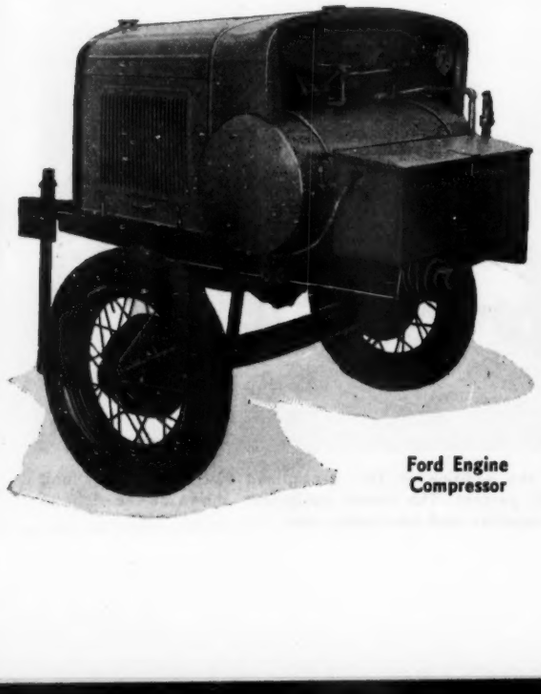
This can be done by using a Model A Ford engine, with the regular head removed and replaced by a Smith patented compressor head.

The Smith patented head is so constructed that the two outside cylinders generate the power, while the two center cylinders are used for air compression, resulting in a self driven compressor. The use of the strip type, ribbon steel valve, permits a much higher speed than is practicable with any other type of compressor valve, and speeds up to 1400 RPM may be maintained.

Each cylinder has a displacement of 50 cubic inches. With two cylinders compressing and driven at a speed of 1000 RPM; the displacement is 58 cubic feet per minute. The Smith compressor is fitted with a governor that maintains a constant speed of 1250 RPM. At this speed, displacement is 72 cubic ft. free air. It will easily operate one medium jackhammer, paving breaker, tampers, spades, etc.

Desirable features include automatic unloader and idler, engine speed governor, pressure lubrication throughout and electric starter; while the absence of clutches, gears, couplings, etc., greatly simplifies operating and maintenance costs.

Aside from the head, practically all wearing parts are available at Ford Dealers anywhere. Replacement costs are reduced to a minimum, and this results in uninterrupted operation of the Smith compressor.



Ford Engine Compressor

A double capacity unit consists of two of the self driven compressors mounted in one frame, each having its own radiator, and each working independently of the other or working in unison if desired, and each discharging into a common receiver. Unit is wheel or skid mounted as preferred. Wheel mounted equipment includes springs, rubber tires and Timken roller bearings permitting rapid road towing speed.

Full information may be obtained by writing Gordon Smith and Company, Inc., Bowling Green, Kentucky.

Worthington Pumps for Tough Jobs:

Open impeller non-clogging centrifugal pumps for handling solid materials in suspension, gritty liquids, liquids containing stringy material, etc., are now being made in a wide range of sizes

Worthington Monobloc Pump

by the Worthington Pump and Machinery Corporation, Harrison, N. J. The pumps are of compact "Monobloc" construction, the greatest overall length of the largest size being only 23 inches.

They are available in all-iron, all-bronze, or bronze-fitted, and for special services as in chemical plants, breweries, distilleries, canneries, packing plants, etc., such special materials as stainless steel, Everdur, and Monel metal are povided.

Ratings range from 10 to 250 g.p.m. against heads of 10 to 100 feet, ½ hp. to 7½ hp.; 1500 r.p.m. to 3600 r.p.m.; A.C. or D.C.; 50 and 60-cycle; single-phase or poly-phase. In addition, where standard construction does not suit, special constructions and characteristics are available.

The Tractioneer:

The By-Products Steel Corp., Coatesville, Pa., are distributors for Hopkins tractioneers, which are steel tread plates attachable to trucks, graders, shovels, mixers, etc. These perform two important functions—they give remarkable traction, and by reduced unit ground pressure permit "walking over" mud, sand, snow and other soft surfaces. Tractioneers are adaptable to a wide variety of equipment and uses. Mud or snow will not cake between the shoes, it is claimed, or inside of them. The cost is relatively small. A folder containing much information and the results of tests made at Aberdeen Proving Grounds is available on request to George C. Douglas, Tractioneer, Inc., 11th and Hamilton Sts., Philadelphia, Pa.

The "Weldrite" System:

Some valuable information on practical and economical methods of resurfacing asphalt, any bituminous, old brick or cobblestone pavements, is provided in the literature of the Equitable Asphalt Maintenance Co., 1405 Kansas Ave., Kansas City, Mo.

Byers Steel Pipe:

The A. M. Byers Co., Pittsburgh, Pa., long known for their wrought iron pipe, have announced that they will hereafter manufacture steel pipe as well. Further information on sizes, weights and specifications can be obtained from the company.

Air and Electric Hoists:

Many money saving applications of the Sullivan utility hoists are suggested in Bulletin 76-X—a 12 page 2 color book just issued. These compact yet powerful hoists handle materials lifting on construction jobs. Electric and compressed air drive. Ask for Bulletin 76-X, Sullivan Machinery Company, 1600-A Bell Bldg., Chicago, Ill.

Anti-Freeze for Air:

An anti-freeze system for air lines (Tanner Tank and Tannergas) is described in a circular just published by the Sullivan Machinery Company. Guaranteed to prevent freezing at 70 degrees below zero. Odorless, harmless, non-explosive. In use by large mine, quarries and contractors. Ask for circular. Sullivan Machinery Company, 1600-C Bell Bldg., Chicago, Ill.

Power Units:

Five McCormick-Deering power units, one of them Diesel, are described in bulletins just issued by International Harvester Co., 606 So. Michigan Ave., Chicago, Ill. Sent on request.

Elevating Graders:

Caterpillar Tractor Co., Peoria, Ill., has issued a very complete 38-page catalog illustrating and describing its lines of elevating graders. Sent on request.

Descriptions of these free booklets are published to help you obtain needed information quickly

Readers' Service Department

Mail the Coupon For Any of These FREE Booklets

ALSO SEE OTHER DESCRIPTIONS ON PAGES 48 AND 49

Construction Materials and Equipment

Asphalt Heaters

9. Illustrated manual No. 11 describes "Hotstuf," the master oil burning heater. The only heater with patented elevated melting chamber for Asphalt, Tar and all bitumens used in road and street construction and maintenance, roofing, water proofing, pipe coating, etc. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Safety Signals

10. Reduce accidents on your construction work with effective, yet simple, low-cost safety signals. Especially designed for safety in construction, on street work, highways and water and sewer construction. Write for Bulletin 322 illustrating a variety of types. Martindale Electric Co., 1378 Hird St., Cleveland, O.

Bituminous Mixer Time Lock

11. Time locks on tar and asphalt paving plants are required by many states for better control of mixer. Bulletin TL-12 describes the "all mechanical time lock" which insures a better product. Fits any plant. Information from Hetherington & Berner, Inc., 701 Kentucky Ave., Indianapolis, Ind.

Concrete

28. "Better Concrete" sums up good concrete construction practice for the benefit of the man on the job, illustrating every step in the making of concrete with instructive and excellent photographic views. Also, how "Incor" 24-hour cement makes it easy to get good concrete at lower cost. This is a worth-while book. Write "Incor" Cement, Room 2208, 342 Madison Ave., New York, N. Y.

Concrete Accelerators

30. "How to Cure Concrete," a forty-seven page manual published by the Dow Chemical Company, Midland, Michigan, treats fully subject suggested by title.

31. "Curing Concrete Roads with Solvay Calcium Chloride," 30 page booklet. Comprehensive. Contains tables, illustrations, suggestions for testing devices. Covers the subject in considerable detail. Solvay Sales Corp., 61 Broadway, N. Y. C.

35. A new, leather-bound manual giving complete details for curing concrete in all kinds of weather with calcium chloride has just been issued by Columbia Alkali Corp., Barberton, Ohio. Pocket size, flexible, contains 54 pages of text and 32 pages ruled for notes. Also contains many useful tables.

36. "Wyandotte Calcium Chloride and its use in Portland Cement Concrete," a booklet covering the subject of curing concrete pavements, structures, etc., giving complete specifications for surface and integral curing. Published by the Michigan Alkali Co., 60 East 42 St., New York, N. Y.

Concrete Mixer

44. Concrete Mixers, both Tilting and Non-Tilting types, from 3½s to 84s size, The Jaeger Machine Company, Columbus, Ohio.

Concrete, Vibrated

50. Data on methods and equipment for, and the results obtained from the use of, vibrating equipment on thin walls, pavements, culverts, bridges, floors and other concrete construction. Munsell Concrete Vibrators, Teaneck, N. J.

Concrete Vibrators

51. Concrete vibrators with either gasoline engine or electric motor power units for large mass concrete and thin walls on all types of concrete structures are illustrated in a new catalog issued by Mall Tool Company, 7745 South Chicago Ave., Chicago, Ill.

Culverts

60. "In diameters up to 10 feet and larger . . . " just issued by the Armco Culvert Mfrs. Assn., tells a good deal about drainage problems and their solution. 32 pages about drainage and multi-plate culverts.

Expansion Joints

68. How TRANSLODE Air-Core Expansion Joints cut costs, eliminate dowel bars and control the cracks is told in a new booklet just issued by Highway Steel Products Co., Chicago Heights, Ill. Lots of action pictures of actual installations.

Gasoline Power Hammer:

75. This portable gasoline driven hammer is light enough to be handled readily, but powerful enough for heavy breaking work. Very economical for municipalities and counties. No air compressor needed—entirely self-powered and self-contained. Low first cost, low operating cost and low maintenance cost. Costs and information on request. Barco Mfg. Co., 1807 Winnemac Ave., Chicago, Ill.

Stone and Gravel Crusher

77. Full information on the Pioneer jaw crusher, with dimensions and specifications, also important points about quarry and screening plants, and percentage chart showing various sizes of stone produced by the crusher for various settings. Pioneer Gravel Equipment Mfg. Co., 1527 Central Ave., Minneapolis, Minn.

Hose and Belting

87. Complete information on rubber hose and belting for all types of contracting and road building service. The Government Sales Department of the Goodyear Tire & Rubber Co., Inc., Akron, Ohio.

Loaders and Unloaders

97. Portable Loaders and Unloaders. Folders: Nos. 1248, 1298 and 1074 cover Belt Conveyors with channel iron and truss types of framework; No. 1076, Portable Bucket elevators for different classes of work; and No. 1256, the "Grizzly" Crawler Loader for heavy work and large capacities. Link-Belt Company, Philadelphia.

Motor Trucks

105. "What is Quality in a Motor Truck," is a new booklet containing valuable information for the prospective buyer of motor trucks. While this booklet refers especially to 1½ to 2-ton trucks, many of the facts contained in it are also applicable to heavy-duty units. Sent free on request by International Harvester Co., 606 South Michigan Ave., Chicago, Ill.

Mud-Jack Method

107. How the Mud-Jack Method for raising concrete curb, gutter, walls and streets solves problems of that kind quickly and economically without the usual cost and time-consuming reconstruction activities—a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee, Wis.

Paving Materials

109. The maintenance of all types of roads, streets, and pavements is fully described in the 52 pages of a new booklet, just issued by The Barrett Company, 40 Rector St., New York, N. Y.

Each step in the various processes is given in detail and illustrated with photographs of actual operations.

Re-surfacing is covered as well as routine maintenance. Road officials will find this new booklet a mine of useful information.

112. Complete directions for surface Cut Back Asphalt are contained in a 36 treatment and bituminous surfacing with page data book. Standard Oil Co. of Indiana, 910 So. Michigan Ave., Chicago, Ill.

Pumps

121. New catalog and new low prices of Jaeger sure prime pumps, 2" to 6" sizes, just issued by Jaeger Machine Co., 400 Dublin Ave., Columbus, Ohio.

Road Building and Maintenance

126. Action pictures show steps in road construction and maintenance, covering grading and ditching, rough grading, gravel and stone road construction,

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bituminous surfacing, fine grading and paving, summer and winter maintenance, municipal work and material handling, and illustrate Austin-Western equipment on such work. Ask for publication 1365 Austin-Western Road Machinery Co., Aurora, Ill.

Portable Stone Crushers

130. "If you have hand labor, if you have roadside rock, and if you want better roads" is the title of a 4-page publication issued by Pioneer Gravel Equipment Mfg. Co., 1527 Central Ave., Minneapolis, Minn. Information and specifications are given briefly regarding the Pioneer crusher trailer, which is a very simple and economical unit. Will travel any place that a tractor will go. Write for copy of this bulletin.

Rollers

132. The NEW Buffalo - Sprinfield Special Three-Axle Rollers for all kinds of precision rolling, especially of bituminous materials either hot or cold, are described in an illustrated pamphlet just issued by the Buffalo-Springfield Roller Co., Springfield, Ohio.

Sand and Gravel Washing Plants

140. Seventy-page catalog giving complete information regarding Sand and Gravel Washing Plants, stationary and portable. Those interested in such equipment should have a copy. Link-Belt Co., Chicago, Ill.

Shovels, Cranes and Excavators

145. The Austin Badger, a new, fully convertible ¾ yard crawler shovel, made by The Austin-Western Road Machinery Co., No. A-5, Aurora, Ill., is fully described and illustrated in their Bulletin No. 1236.

Spreader

147. The Jaeger *Adjustable* Spreader for smoothly spreading stone, macadam and bituminous—1" to 7" thickness, 8 to 11 ft. width is described and illustrated in a new catalog now ready for distribution. Issued by Jaeger Machine Co., 400 Dublin Ave., Columbus, Ohio.

Soil Stabilization

150. Explicit instructions for testing soils and constructing and maintaining low-cost stabilized roads are contained in two excellent new booklets. No. 1 contains brief specifications for construction. No. 3 makes clear the procedure in sampling and calculating mixtures. Both are well illustrated with tables of useful information, charts and photographs. Just published by Solvay Sales Corp., 61 Broadway, New York, N. Y.

151. Full information and details regarding gravel-clay stabilized roads and the Pioneer portable stabilizer plant can be obtained from the Pioneer Gravel Equipment Mfg. Co., 1527 Central Ave., N. E., Minneapolis, Minn.

Tires, Truck and Tractor

165. Speed and economy in use of solid, cushion and pneumatic tires and tubes for trucks, cars, tractors, graders and other road machinery. Government Sales Department of the Goodyear Tire & Rubber Company, Inc., Akron, Ohio.

Tractors—Diesel and Gasoline

185. The various applications of Cleveland tractors to economical grading, road maintenance, bull-dozing, dirt moving, pipe handling and other work are illustrated in a booklet issued by Cleveland Tractor Co., Cleveland, O.

Waterproofing

190. A brief technical report covering all information necessary in specifying or applying waterproofing or dampproofing on grade crossing elimination projects. Copies may be had without charge from Koppers Products Co., Koppers Building, Pittsburgh, Pa.

Street and Paving Construction

Asphalt Mixing Plants

204. A new illustrated bulletin No. M234 describing their asphalt mixers for bituminous paving mixtures of all kinds has just been issued by Hetherington & Berner, Inc., 701 Kentucky Ave., Indianapolis, Ind. Covers both steam-jacketed, steam operated; and hand operated types. Sent on request.

Dust Control

209. "3000 men put back to work in a single county." A new folder just issued by the Solvay Sales Corp., 61 Broadway, New York City, outlining a road program which is a relief program. Sent promptly on request.

210. "How to Maintain Roads with Dowflake" is a new 58 page illustrated booklet of information on stabilized road construction. Includes specifications and several pages of reference tables from an engineer's notebook. Just issued by Dow Chemical Co., Midland, Mich.

211. Methods of Dust Control and Road Stabilization with 3C calcium chloride are illustrated and described in a new, non-technical bulletin just issued by Columbia Alkali Corp., Barberton, Ohio.

212. "Wyandotte Calcium Chloride Prevents Dust the Natural Way"—a publication, fully illustrated, treating on Dust Control, economical road maintenance and methods of application, issued by the Michigan Alkali Company, 60 E. 42nd St., New York City.

Dust Laying

213. Full information regarding the use of Solvay Calcium Chloride for effectively laying dust. The booklet, "Solvay Calcium Chloride, a Natural Dust Layer," 24 pages, 5½x8, covers application, economies, etc. Sent without cost. Solvay Sales Corporation, New York.

Bituminous Materials

227. "Asphalt for Every Purpose," a 44 - page illustrated booklet describing Stanolind Asphalt products. Standard Oil Co. of Indiana, 910 So. Michigan Ave., Chicago, Ill.

228. A new booklet has just been issued by The Barrett Co., 40 Rector St., New York, describing and illustrating the uses of each grade of Tarvia and Tarvia-lithic, 32 excellent illustrations.

229. A new series of concise and authoritative manuals of construction covering the latest developments in road-mix and surface treatment types as well as the standard asphalt pavements. These contain the best that has been developed by study, research and practical application in all types. Manual 1—Road-Mix Types is now ready for distribution. The Asphalt Institute, 801 Second Avenue, New York, N. Y.

229A. Surface Treatment Types Asphalt Road Construction Manual No. 2. Full details on surface treatments. 14 chapters, 128 pages. The second of those tremendously valuable and handy little manuals put out by the Asphalt Institute. 801 Second Avenue, N. Y. Sent on request.

Brick Paving

230. Recommended standard specifications for vitrified brick pavements and brick parking strips and gutters, as submitted to the American Society of Municipal Engineers. If you contemplate using brick for paving, you should have a set. National Paving Brick Ass'n., Washington, D. C.

Noiseless Manhole Covers

403. Nuisance from loose, noisy manhole covers is eliminated by the use of Westeel rubber cushioned manhole covers and gratings. Six special advantages are explained in a new illustrated bulletin just issued by the West Steel Casting Co., 805 East 70th St., Cleveland, Ohio.

Surface Heaters

220. The "Hotstuff" three in one, combination Tool, Asphalt and Surface heater is described and its use illustrated in Bulletin 6. Mohawk Asphalt Heater Co., Frankfort, N. Y.

Ice Control

233. Ways of using rock salt as a cheap and effective means of ice control for streets and highways are described in a new bulletin issued by International Salt Co., Scranton, Pa.

Concrete Curing

235. "How to Cure Concrete," is a manual of instruction on the curing of concrete pavements. 47 pages. The Dow Chemical Company, Midland, Mich.

Gutters

240. "Brick Gutters and Parking Strips." A study dealing with the problems faced in the proper construction of gutters and how they can be overcome. Covers design, construction and results. Well illustrated. Just issued by the National Paving Brick Ass'n, National Press Building, Washington, D. C.

Jacking Culverts

260. No interruption to traffic, and substantial savings in construction costs are the main advantages secured by using the Armco jacking method to install conduits, drainage openings, and passageways under streets, highways and railroads. "The Armco Jacking Method," describing this modern means of construction and its many applications, will be sent upon request, by Armco Culvert Mfrs. Association, Middletown, Ohio. Ask for Catalog No. 7.

Snow Plows

349. "V Type Sno-Plows for Every Size Motor Truck" describes and illustrates all features of the Frink V type plow, including the new power hydraulic control as well as the earlier types of lifting devices. Also describes and illustrates 14 styles of leveling wings and the different attachments which may be used in connection with them. Just issued by Carl H. Frink, Mfr., Clayton, N. Y.

Sanitary Engineering

Activation and Aeration

380. A valuable booklet on porous plates and porous tubes. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability. 20pp. illustrated. Sent on request to Norton Company, Worcester, Mass.

Sewer Cleaning Machines

384. A new Power Sewer Cleaner is described in a bulletin now ready for distribution by the Champion Corporation, 4718 Sheffield Ave., Hammond, Indiana. For 25 years this corporation has built a line of sewer cleaning apparatus which has given excellent service. Write for bulletin.

Couplings for Pipe

386. This sixteen-page booklet is a reprint of a magazine article by a consulting engineer. It describes in detail the installation of a 42" water line; contains specific information regarding pipe joints, field organization, laying pipe, tests, back-filling, etc. Sent free by S. R. Dresser Manufacturing Company, Bradford, Pa.

Glass Covers

393. Full details regarding the use of Lord & Burnham Glass-Overs at Middletown, N Y.; Marion, Ohio; Cleveland, Ohio; Freeport, N. Y.; Kitchener, Canada; West Chester, Pa., and other places are given in bulletins 22 to 33. Sent promptly on request to Lord & Burnham Co., Irvington, N. Y.

Manhole Covers and Inlets

403. Nuisance from loose, noisy manhole covers is eliminated by the use of Westeel rubber cushioned manhole covers and gratings. Six special advantages are explained in a new illustrated bulletin just issued by the West Steel Casting Co., 805 East 70th St., Cleveland, Ohio.

404. Street, sewer and water castings made of wear-resisting chilled iron in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter crossing plates, valve and lamphole covers, ventilators etc. Described in catalog issued by South Bend Foundry Co., South Bend, Ind.

Readers' Service Department

CONTINUED FROM PAGE 48

These booklets are FREE to readers of PUBLIC WORKS.

Pipe Forms

409. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe Joints

410. New folder describes in detail a new type of pipe joint—the Dresser Compression Coupling, Style 65, which is compact and self contained, makes a permanently tight joint under all conditions and is installed on plain end pipe in a few seconds with only one tool, a wrench. Get your copy today. S. R. Dresser Mfg. Co., Bradford, Pa.

Taste and Odor Control

411. How, when and where activated carbon can and should be used to remove all kinds of tastes and odors from water supplies is told in a new booklet just issued by Industrial Chemical Sales Co., Inc., 230 Park Ave., New York, N. Y. 32 pages, table, illustrations and usable data.

Pumping Engines

413. "When Power Is Down,' gives recommendations of models for standby services for all power requirements. Sterling Engine Company, Buffalo, N. Y.

Pumps

415. "Built-together" pump units in capacities up to 250 gpm and heads to 190 ft. are described in Bulletin 5550, which also gives selection tables. Fairbanks, Morse & Co., 900 So. Wabash Ave., Chicago, Ill.

Runoff & Stream-Flow:

416. Technical information on measuring run-off, both from small areas, for storm sewer design, and from large areas for determining water-shed yield, and instruments for measuring. Julien P. Friez & Sons, Baltimore, Md.

Screens, Sewage

417. The simple, automatic Loughlin self-cleaning traveling screen is fully described in a new bulletin just issued by Filtration Equipment Co., 10 East 40th St., New York, N. Y.

418. Sewage screens (Tark, Brunotte, and Straightline) for fine and coarse sewage; Straightline Collectors for Settling Tanks (Sludge, Scum and Grit), and Mechanical Aerators for activated sludge plants. Link-Belt Company, 910 So. Michigan Ave., Chicago, Ill. Book 642.

Rainfall Measurement:

419. The measurement of precipitation, exposure of gauges, description of apparatus for measuring rainfall, both rates and amounts. Bulletin RG and Instruction Booklet. Julien P. Friez & Sons. Baltimore, Md.

Screens

420. Water Screen Book No. 1252, describes water screens and gives complete technical information about them. Link-Belt Co., Chicago, Ill.

Sewerage Pumps

421. Sewage and trash pumps for handling liquids containing solids. Dimensions, performance, rating, curves and specifications. Bulletin 5410. Fairbanks, Morse & Co., 900 So. Wabash Ave., Chicago, Ill.

Sludge Bed Glass Covers

422. Sludge Bed Glass Covers—"Super-Frame." Hitchings & Co., Elizabeth, N. J. Offer A. I. A. File 101SB, describing glass covers for sludge and sprinkler beds; details, specifications and cost data.

Sludge Drying

424. Relatively dry cake sludge in demand for fertilizer is produced by automatic continuous vacuum filters like those used in Milwaukee, Houston, Chicago, Gastonia, N. C., Charlotte, N. C. Write for literature. Oliver United Filters, Inc., 33 West 42nd St., New York, N. Y.

Sludge Incineration

428. Disposal of Municipal Refuse: Planning a disposal system; specifications. The production of refuse, weights, volume, characteristics. Fuel requirements for incineration. Suggestions for plant inspection 45 pp., Ill. Also detailed outline of factors involved in preparation of plans and specifications. Morse-Boulger Destructor Co., 202P East 44th St., N. Y.

Sludge Removal Equipment

429. If you are interested in economical sludge removal, write for the latest bulletin describing and illustrating Louden Monorail equipment which is adapted to open or closed beds. Full details sent promptly by the Louden Machinery Co., 400 West Ave., Fairfield, Iowa.

Swimming Pool Equipment

430. Filters, chlorination, underwater lights and other supplies for swimming pools are very thoroughly described in literature and folders. Plans and layouts. Everson Filter Co., 625 W. Lake St., Chicago, Ill.

Treatment

433. Installation views and considerable engineering data including capacity tables for settling tanks and layouts of typical arrangements for both final and primary tanks, are contained in a new booklet—No. 1542—just published for engineers by Link-Belt Company, 910 South Michigan Ave., Chicago, Ill.

435. A new series of bulletins describing their full line of sewage treatment equipment—Fine Screens, Schofield Bar Screens, Vacuum Filters for Sewage Sludge, Decarie Screenings Incinerators, Schofield Bar and Fine Screens, Vacuum Filters for Sewage Filtration and Pneumatic Ejectors for Sewage Screenings—are ready for distribution on request to Municipal Sanitary Service Corp., Room 2703, 155 East 44th St., New York, N. Y.

436. Separate bulletins showing their many lines of sewage treatment equipment will be sent promptly by The Pacific Flush Tank Co., Chicago and New York. The latest is No. 110 describing tray clarifiers.

438. Eliminate sludge bed troubles, forget about weather conditions, odor nuisance, hail insurance and the like. Full details as to how Oliver United Vacuum Filters overcome these problems will be sent to all interested by Oliver United Filters, Inc., 33 West 42nd St., New York, N. Y.

440. Complete information is now available concerning the Putnam system of odorless, non-bacterial sewage treatment. Causes no nuisance and produces saleable by-products. Details sent promptly by A. R. Putnam, Box 185, Benton Harbor, Mich.

441. Collectors and concentrators for modern sewage treatment plants, recent installations, and full data on aerators, and screens. Link-Belt Co., 910 So. Michigan Ave., Chicago, Ill., and Philadelphia.

442. Full information regarding their newest equipment for sewage treatment and water purification will be sent on request by The Dorr Co., 247 Park Ave., New York, N. Y.

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For the Engineer's Library

The editors will be glad to assist readers in getting copies of publications mentioned here.

"Noise"

Dr. N. W. McLachlan; Oxford University Press, New York, 150 pp., $2.25.

The cause and measurement of, as well as the remedy for, annoying sounds, are discussed from those which are faintly audible to those which, emanating from that noisiest of all machines, the airplane, border on feeling.

The author devotes an entire chapter to airplane and motor vehicle noises, and explains how and why the exhaust of automotive engines can be silenced without adversely affecting performance. Once that is done, he says, attention can be turned to the job of silencing the other noise-producing parts of a motor vehicle.

For those seeking new worlds to conquer, the book presents definitions of decibels, reftones, and other words associated with noise and growing in use with anti-noise crusades.

Black and White Magic:

A new process which enables the engineer to make blackline (black and white) prints without the use of a negative, and faster than he can make blue prints, is described in a booklet which you can get without cost by writing to Charles Bruning Co., Inc., 102 Reade St., New York, N. Y.

Practical Methods Applied to Paving:

Here is a booklet, largely pictorial, which shows some extremely horrible examples of old, rough, rutted and broken down cobble, brick, block and other streets—and also the same streets after they have been surfaced by the asphalt heater method. Also contains dope as how it's done. Copy on request. Equitable Asphalt Maintenance Co., Kansas City, Mo.

Results of Municipal Lighting Plants, 1935

Burns & McDonnell Engineering Company, 107 West Linwood Boulevard, Kansas City, Missouri. Price $1.

This 1935 edition shows what 415 representative cities pay for electricity. The past year has brought about many drastic rate changes, both in private and municipal plants. The new book covers many more cities than last year's edition.

The little volume is a unique and informative record of the rates, earnings, operating expenses, net profits, kilowatt-hour production, and other information pertaining to the use and cost of electricity. Officials, operators and managers will find it valuable.

The Municipal Smoke Problem:

This 20-page booklet by H. B. Meller and L. B. Sisson of the Mellon Institute of Industrial Research, Pittsburgh, Pa., is an excellent exposition of the causes of smoke in cities and of the methods—or some of them—for control. A reading of it will give a broader and better understanding of the problem and a realization of its importance. The text is so arranged that it may be used as presented, for instruction purposes or parts included in the courses in chemistry and physics. Sent on request; no charge.

Centrifugal Pump Data:

A handy reference bulletin on centrifugal pumps for virtually every purpose has been published by Morris Machine Works. While the bulletin is primarily intended to illustrate and list the various designs of Morris pumps, hydraulic dredges, and steam engines, it is practically a guide book of centrifugal pumps because the Morris line includes single and multi-stage pumps, both horizontal and vertical, for handling clear water, fine and coarse abrasive mixtures, pulpy materials and chemical liquids on every conceivable service. In addition, the bulletin also includes considerable information which would be useful to centrifugal pump users. Copies from Morris Machine Works, Baldwinsville, New York. Ask for Bulletin 157.

Armco Sewers:

A 6-page booklet describes Armco paved invert sewers, which are made of corrugated Armco iron, and paved with a special asphalt. Dope and pictures. Armco Culvert Mfrs. Assn., Middletown, O.

Safe Driving:

"I Drive Safely," a book of instructions for drivers of trucks and buses, is available from International Harvester Co., Chicago, Ill.; 64 pages on speed, brakes, hills, carbon monoxide, road rules, safety loading, steering, tires, heavy traffic, slippery roads and lots of other factors. Free on request.

Charts for Earthmovers:

These give the probable production and cost of earth moving with the 12-yard Le Tourneau Carryall, and show the grades over which the Carryall and the big "Buggies" may be pulled, loaded and empty, by a "Cat" 75 tractor. For free copy, write George McNutt, R. G. Le Tourneau, Inc., Peoria, Ill.

Air Lift Pumping System:

The Ingersoll-Rand method of Air Lift Pumping of water, oil, or other fluids is described in a recently-issued 24-page bulletin. The advantages of air lift pumping over other methods for certain field conditions are brought out, several applications are illustrated and described, the theory of air lift pumping is set forth in detail, and a number of different compressors for supplying the air are shown. A copy of this bulletin, No. 9042, can be obtained from Ingersoll-Rand Company, 11 Broadway, New York, or any branch office.

Diesel Dope:

"The Why's and How's of Diesel Engines" answers a whole lot of questions on diesel engines. Write Caterpillar Tractor Co., Peoria, Ill., for free copy.

Sewage and Sludge Pumps:

The Lawrence Machine & Pump Corp., 371 Market Street, Lawrence, Mass., has issued Bulletin 206 covering their sewage and sludge pumps. The Bulletin describes thoroughly the construction of this line of pumps, both horizontal and vertical drives, and includes several interesting cuts and installation views. It should be of special interest to engineers, sewage plant superintendents and others bothered with the pumping of sewage and sludge.

Snow Removal:

Cleveland Tractor Co., Cleveland, O., has issued another attractive bulletin or folder on snow removal, which shows Cletrac equipment for this work. Write for free copy.

Gaskets:

Goetze Gasket & Packing Co., Inc., New Brunswick, N. J., has issued Catalog 48 on metallic and semi-metallic gaskets, sheet and stuffing box packings, sealing compounds, gasket cutting tools, valve discs, filter screens and metal stampings. This 64-page booklet describes many new gasket types, is well illustrated with halftones and blueprint diagrams, size and price data, and is prepared as a guide to all who specify, purchase or use gaskets and packing. A copy will be sent free on request to the manufacturer.

U. S. Civil Service:

Engineering Draftsmen. — Application for chief engineering draftsmen ($2,600 per year) and engineering draftsmen ($2,300) for work on ships will be received at Washington, D. C., till Jan. 6, 1936. Full information from U. S. Civil Service Board, Washington, D. C., or first and second class post offices.

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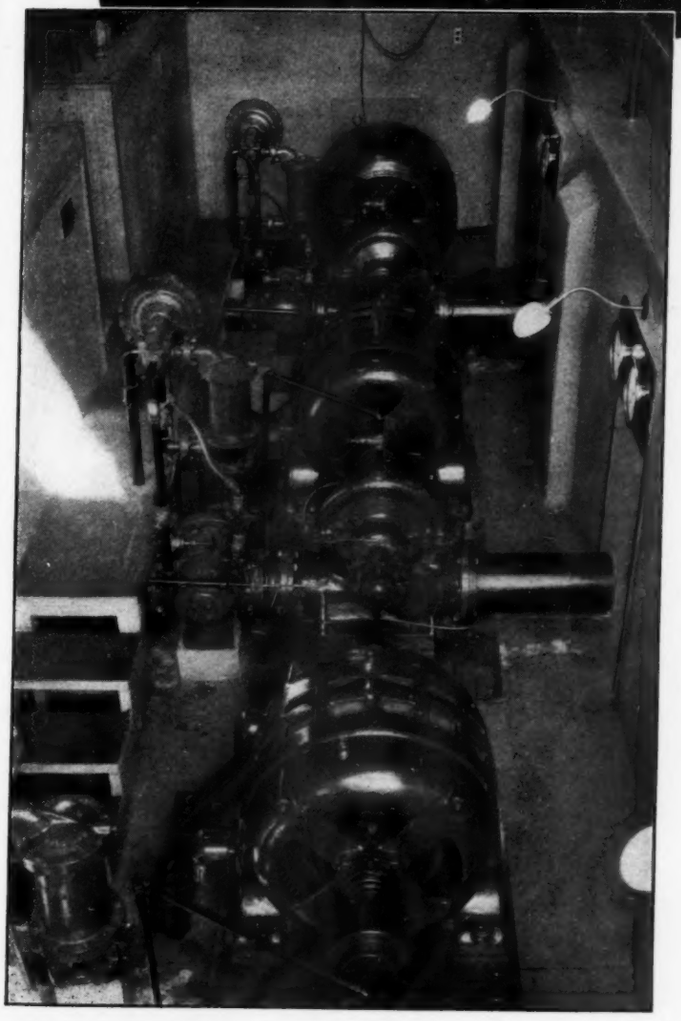

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